OPERATOR'S MANUAL //

ANYmal (gen. D)

Original instructions

Document number: ANY-TECR-000005-00

Published date: Friday, October 27, 2023

Document version: 2.5

Read this manual before using the equipment

Retain this manual for future use

Published on: 10/27/2023
Document ID: ANY-TECR-000005-00 - 2.5

Copyright

Intended purpose

The purpose of this document is to familiarize you with ANYmal (gen. D) and ensure that the equipment can be used safely, effectively and efficiently. This manual is divided into different chapters addressing different use cases: installing, commissioning, operating, maintaining, cleaning and troubleshooting ANYmal (gen. D).

Additional information is provided in the Software Guide and Software Development Guide in the ANYmal Software Manual.

Find the latest version of this document through the support site: https://support.anybotics.com

Target audience

This manual is intended for the Operators of ANYmal (gen. D). It conveys information on how to understand and fulfil the respective work and duties.

It assumes that the Operators have a technical background and have been trained to safely use ANYmal (gen. D). A good understanding of written English is a pre-requisite to understand the information provided.

Contact address

ANYbotics AG
Hagenholzstrasse 83a
8050 Zurich
Switzerland
https://www.anybotics.com

Terminology

The following lists some of the important terms that are needed to understand this manual.

Term	Definition
Bystander	A person who can be reasonably expected to be near ANYmal (gen. D) and is instructed to safely share the workspace with ANYmal (gen. D) under the responsibility of the User.
Robot	Refers to the four-legged robot platform, ANYmal (gen. D).
Inspection payload	Equipment attached to the Robot used for collecting data.
Wide angle camera	A camera used to detect areas around the Robot.
Depth camera	A camera used to aid movement.
Actuator	Precision motor used at leg joints.
LIDAR unit	Light detection and ranging unit. Used to aid environment detection and movement.
User	Entity that uses ANYmal (gen. D) for the intended use and is responsible for the personnel associated with the Robot operation (Operators) and any person who can be reasonably expected to be near ANYmal (gen. D). (Bystander).
Master Operator	Skilled person that is trained by ANYbotics in installing, commissioning, operating, maintaining, cleaning and troubleshooting ANYmal (gen. D) and instructing Operators and Bystanders under the responsibility of the User.
Operator	Skilled person that is trained by ANYbotics or a Master Operator in installing, commissioning, operating, maintaining, cleaning and troubleshooting ANYmal (gen. D) and instructing Bystanders under the responsibility of the User.
Robot shells	Protective plastic shells used on the Robot.
Hoist points	Safe points to use when lifting the Robot.
Mission	A term used to describe a series of tasks performed by the Robot.
Work environment	The space where the Robot can move and perform tasks.
Operation environment	The environment in which the Robot operates. The Operation environment consists of the following: ■ Work environment. ■ Infrastructure, for example, network and power. ■ 3D map for localization. ■ Waypoints and paths for navigation. ■ Points of interest for inspection. ■ Tasks, missions and Robot behaviors for inspection tours.

Term	Definition
Operator graphical user interface (GUI)	A graphics-based operating system interface that the Operator uses to interact with the Robot.
Environment objects	Objects that the Robot encounters in the operation environment.
Operator computer	The computer used by the Operator to operate the Robot.

Versions

Version	Publication date	Changes
1.9	09-Dec-2022	ANYbotics Workforce app help added. Gas detection functionality added.
1.8	19-Oct-2022	Updates to 7.1.2.2 "*Reconfigure the LTE connection*". Updates to 6.8.1 "*Record waypoints in the Graphic User Interface (GUI)*" for new feature to automatically load saved waypoints for autonomous navigation.

CONTENTS

1 SAFETY INFORMATION

The Robot is a powerful moving machine and weighs more than 50 kg. Therefore, it is important that you carefully read and understand the following instructions for safe operation of the Robot.

In addition to these safety instructions, you must also comply with all local and site specific health and safety regulations and environmental protection requirements.

1.1 User, Master Operators, Operators and Bystanders

The User is the entity that uses the Robot for the intended use and is responsible for the personnel associated with the Robot operation, the Master Operators and Operators, and any Bystander who can be reasonably expected to be near the Robot.

The Robot can only be used in work environments, where all persons, Master Operators, Operators and Bystanders, are trained or instructed to safely share the workspace with the Robot under the responsibility of the User.

Manufacturing and service support work may only be carried out by the specialist service personnel employed by ANYbotics or personnel authorised by ANYbotics. Other personnel are not authorised to carry out this work.

If your Robot requires any manufacturing or service support, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

1.1.1 The User

The User is subject to the legal responsibility for occupational safety and bears legal responsibility for the Robot during operation for the protection of the Master Operators, Operators, Bystanders or any third party.

In addition to the safety instructions in this manual, the applicable safety regulations, as well as occupational safety and environmental regulations must be implemented for the area of application of the Robot.

This applies in particular to the following:

- The User must inform themselves of the applicable occupational safety regulations and conduct a risk assessment to identify any additional risks that may arise due to the special working conditions at the Robot location.
- This information must be implemented in the form of operating instructions for the operation of the Robot.
- During the entire period of Robot use, the User must ensure that the operating instructions created reflect the current state of policy and adjust them if necessary.
- The User must clearly implement and define the responsibilities for installation, commissioning, operation, troubleshooting, maintenance and cleaning.
- The User must undertake that all persons who work with the Robot have read and understood this manual.

- The User must make all site staff aware that the Robot is present and operating in the area.
- The User must make all site staff aware of the safe operating area around the Robot.
- The User must provide Master Operators, Operators and Bystanders with the required protective equipment and must undertake that Master Operators, Operators and Bystanders wear the required protective equipment.
- The User is responsible for ensuring that the Robot is always in good working order. The following therefore applies:
  - The User must ensure that the maintenance intervals described in this manual are observed.
  - The User must have all safety functions regularly checked for functionality and completeness.
  - The User must ensure that any additional required safety functions are available and functional.
  - The User must ensure that the required fire protection measures are always compliant and functional.
- The User is advised to perform their own risk assessments.

1.1.2 The Master Operators and Operators

All Operators should have previous knowledge of Robot operating technology or comparable techniques in order to operate the Robot optimally.

Master Operators must have been trained by ANYbotics in installing, commissioning, operating, maintaining, cleaning and troubleshooting ANYmal and instructing Operators and Bystanders, while Operators must have undergone specialist training by Master Operators or ANYbotics.

This enables Master Operators and Operators to carry out Robot operation, as well as certain maintenance and repair work in a professional and safe manner. This includes the following:

- Switching the Robot on and off
- Setting up the Robot
- Operating and monitoring the Robot
- Preparing, executing and completing inspection tasks
- Cleaning the Robot
- Doing certain maintenance work according to the maintenance plan

1.1.3 The Bystanders

Bystanders are persons who do not directly operate or interact with the Robot, but are in the workspace of the Robot. Bystanders must have been instructed by Master Operators or Operators to safely share the workspace with the Robot.

1.2 Safety notices

The following safety notice formats are used in this manual. Safety notices are used at the start of sections or embedded in operating instructions.

Ensure you fully understand and comply with the notices in this manual.

DANGER

Risk of death!

Indicates a hazardous situation which, if not avoided, will almost certainly result in death or serious injury.

Warning

Risk of serious injury or death!

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

Caution

Risk of injury!

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Notice

Indicates an important situation which, if not avoided, may seriously impair operations.

Tip

Additional information relating to the current section.

1.3 Special safety instructions

To draw attention to special hazards, the following symbols are used in this manual.

Symbol	Meaning
	Automatically starting equipment
	Bright or intense light source
	Crush or trapping hazard
	Electrical hazards and electrical shock hazard
	Fire hazard
	General warning
	Heat and high temperatures
	Heavy objects or equipment
	Laser hazard
	Sharp edges or equipment

1.4 Intended use

The Robot is intended exclusively for use in accordance with the details provided in this manual. The Robot is to be used to perform autonomous, supervised or operated remotely inspection tasks in industrial environments by trained Master Operators and Operators.

Intended use includes compliance with all of the information in this manual. Any use that deviates from, or goes beyond the intended use, is considered misuse.

Warning

Danger due to misuse!

Misuse of the Robot can result in hazardous situations.

- Only operate the Robot if it is in an undamaged and orderly condition.
- Never deviate from the prescribed maintenance intervals and procedures.
- Only open or disassemble the Robot or specified components, using the procedures provided in this manual.
- Never modify or attempt to modify the Robot.
- Never allow untrained personnel to operate the Robot.
- Never use in public spaces that are not in control of Master Operators or Operators.
- Never operate the Robot in potentially explosive atmospheres.
- Do not use the Robot or mounted payloads to risk, harm or to intimidate any person, animal or other Robot.
- Do not mount any weaponry on the Robot.
- Do not use the Robot to transport loose goods, animals or persons.
- Do not intentionally provide commands that could lead to falls or collisions of the Robot.
- Do not use the Robot for any illegal purpose.

1.5 Safety functions

The Robot includes several safety functions. These include:

- Robot emergency stop
- ANYbotics Workforce app cut power
- GUI cut power
- Delayed start with warning
- Danger zone active warning light

These functions are used to allow for the safe operation of the Robot.

The emergency stop and cut power functions provide a safe and reliable way of stopping the Robot. The emergency stop and cut power functions can be used when the Robot could be damaged or harm anyone in the vicinity.

1.5.1 Robot emergency stop

> **Warning**
>
> Danger due to collapsing!
>
> When the emergency stop or cut power is activated, the Robot collapses.
>
> Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the emergency stop or cut power is activated on stairs.
>
> When activating the emergency stop or cut power, stand clear and keep all limbs away from the Robot. After activating the emergency stop or cut power, the Robot collapses and there is a crushing hazard.

The Robot has an emergency stop button that immediately disconnects the battery output from the Robot.

When the emergency stop is activated the following happens:

- The computers on the Robot are forcefully shut down.
- Actuators are no longer supplied with power.
- The Robot collapses.

The emergency stop button is located on the top of the Robot.

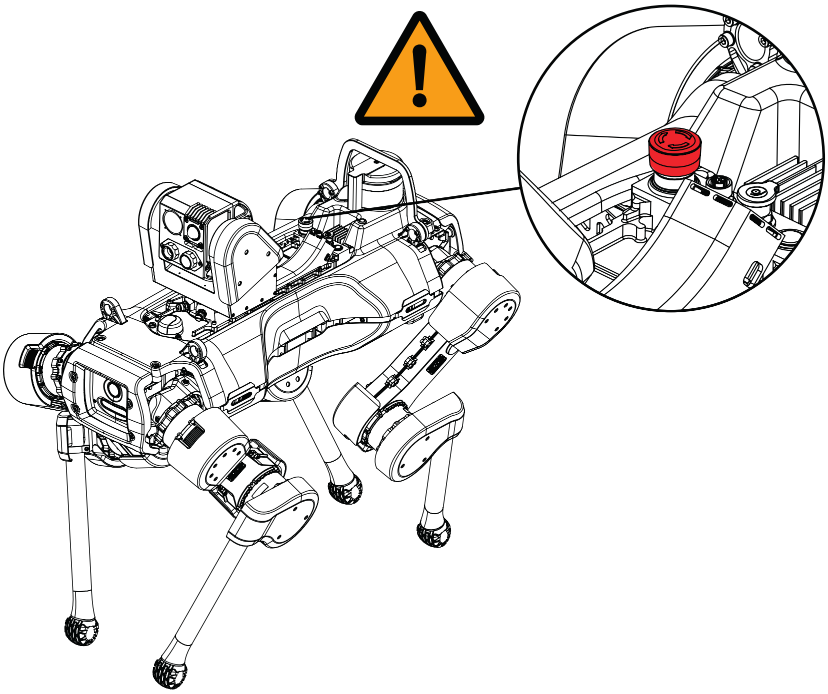


Figure 1 - Location of the Robot emergency stop button

1.5.2 GUI cut power

Warning

Danger due to collapsing!

When the GUI cut power is activated, the Robot collapses.

Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the GUI cut power is activated on stairs.

When engaging the GUI cut power, stand clear and keep all limbs away from the Robot. After engaging the GUI cut power, the Robot collapses and there is a crushing hazard.

Warning

Risk of serious injury or death!

When the GUI cut power is activated, the following happens:

- The Actuators are no longer supplied with power.
- The Robot collapses.

The GUI cut power does not disconnect power to the following:

- Computers on the robot.
- Sensors.

The GUI cut power slider is located at the bottom center of the operator GUI.

► *For more information, see "3.2 Operator graphical user interface (GUI) overview" on page 76*

Activating the GUI cut power has the same effect as using the ANYbotics Workforce app cut power.

Notice

The GUI cut power is implemented and tested carefully but does not comply with ISO EN 13849-1.

1.5.3 Delayed start with warning

Warning

The Robot might enable actuators unexpectedly if a ANYbotics Workforce app operator is using the Robot or an autonomous behavior starts.

Monitor the danger zone active warning light while working near the powered Robot. Leave the danger zone as soon as the danger zone active warning light turns on.

After a request to power the actuators has been received, a nine second delay is initiated. This is indicated by the danger zone active warning light turning on.

► *For more information, see "2.3.5 Danger zone active warning light" on page 57.*

During this period people can leave the danger zone or stop the actuator powering process.

1.5.4 Danger zone active warning light

Warning

Danger due to Robot operating!

When actuators are powered, the Robot could move unexpectedly.

When the danger zone active warning light is on, no person should enter the area within a 2 m radius of the Robot.

► *For more information, see "1.9 Safe operating area" on page 28*

The danger zone active warning light shows when the Robot is about to power the actuators or when the actuators are powered.

The danger zone active warning light is located on the top of the Lidar unit.

► *For more information, see "2.3.5 Danger zone active warning light" on page 57.*

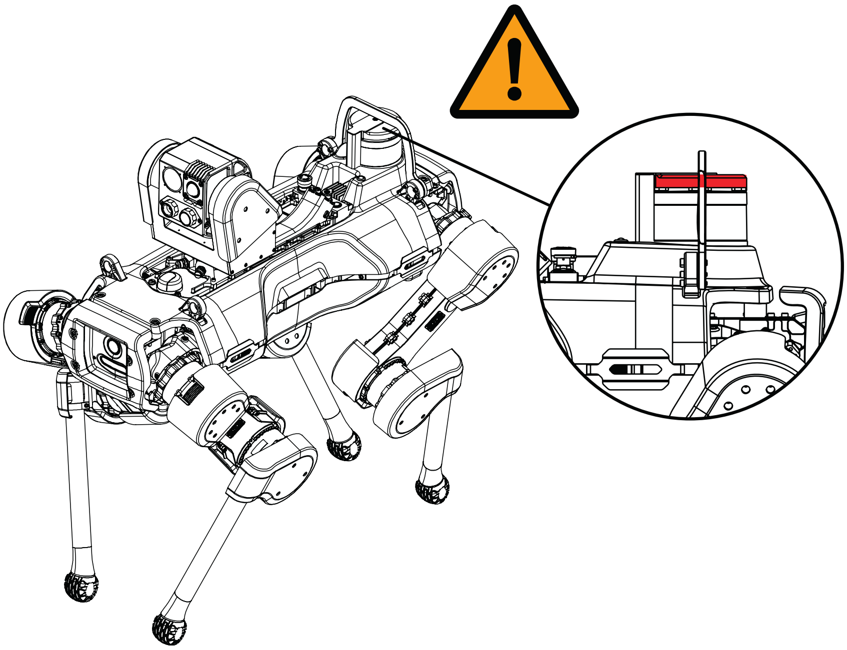
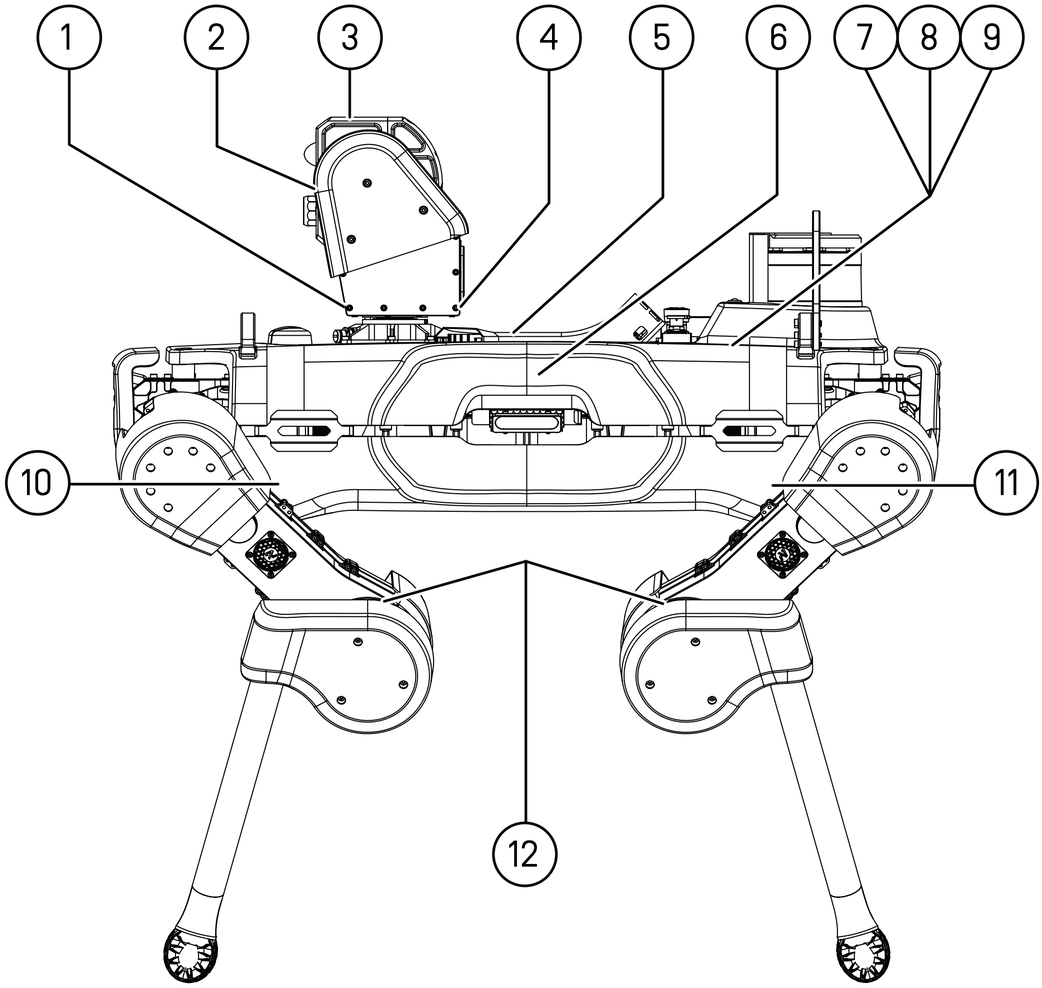


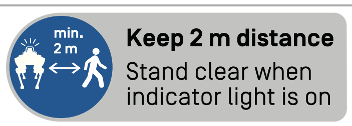
Figure 2 - Danger zone active warning light

1.6 Safety labels

> **Warning**
>
> Risk of injury due to illegible signs!
>
> Any labels or stickers which are found to be illegible must be replaced immediately.

Safety labels are fitted to the Robot to warn you about any potential hazards. These labels must not be defaced or removed.



1		Pinch point (inside housing of inspection payload)
2		Bright light source
3		Hot surface
4		Pinch point (inside housing of inspection payload)
5		Hot surface
6		Keep 2 m distance Stand clear when indicator light is on (both sides of Robot)

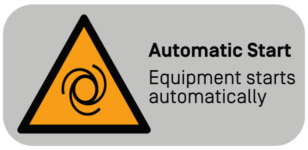
7		Read the manual
8		Automatic equipment start
9		Heavy object Minimum 2 person lift
10		Pinch point (both sides of Robot bottom shell)
11		Pinch point (both sides of the Robot bottom shell)
12		Hot surface (two labels on each leg actuator)

Figure 3 - Location of the safety labels

1.7 PPE requirements and safe operating

> **Warning**
>
> Use personal protective equipment (PPE) as required.
>
> Do not eat, drink or smoke when using Robot.
>
> You must wear a helmet when operating the Robot on elevated platforms or there is a general site-wide safety requirement.

> **Warning**
>
> Do not operate the Robot when you feel tired, stressed or otherwise unfit to operate machinery.

> **Caution**
>
> Be careful when doing work in operating area of the Robot.
>
> Stop autonomous Robot operation while staff are doing any maintenance tasks, or other related work, on site where the Robot is being used.

Consider the following when using PPE:

- Skin protection: Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact from hot surfaces. Replace protective clothing if any deterioration is discovered.
- General hygiene considerations: Handle PPE in accordance with good industrial hygiene and safety practice.
  - Ensure clothing is in good state of repair with no loose fastenings.
  - Wash contaminated clothing before reuse.
  - Wear suitable gloves and eye protection when necessary.
  - Regularly clean the Robot and equipment, work area, and clothing.
- Safety shoes: Wear safety shoes to protect your feet against crushing, falling components and slipping on slippery floor surfaces.
- Trapped hair or loose clothing: Wear protective hair covers to prevent hair from being caught by rotating or moving parts. Also secure all loose clothing.

1.8 Fire precautions

Electrical faults of the Robot, especially failures of the battery or the battery charger can lead to surface heating or fires.

Warning

Risk of fire!

Electrical faults of components of the Robot can lead to fire, which can cause burns or scalding.

The Robot uses rechargeable Lithium-ion polymer batteries. These batteries are potentially hazardous and can present a serious fire hazard if damaged, defective, or improperly used.

If the battery appears swollen or damaged, remove it from the battery charger and discontinue using that battery.

Warning

Risk of hot surfaces!

Electrical faults of Robot components can lead to hot surfaces, which can cause fire, burns or scalding.

1.9 Safe operating area

Warning

Risk of serious injury or death!

Do not enter the danger zone (2 m radius) around the Robot when the danger zone active warning light is on.

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Warning

- Do not stand underneath the Robot when it operates on an elevated platform or stairs.
- Do not try to catch or break the fall of the Robot, if the Robot collapses.

A safe operating area around the Robot is beyond a 2 m radius from the Robot when actuators are in operation. The area within the 2m radius is called the danger zone. When the Robot is active and the actuators are powered, the danger zone active warning light is on.

If you need to approach the Robot, you need to turn off the actuators.

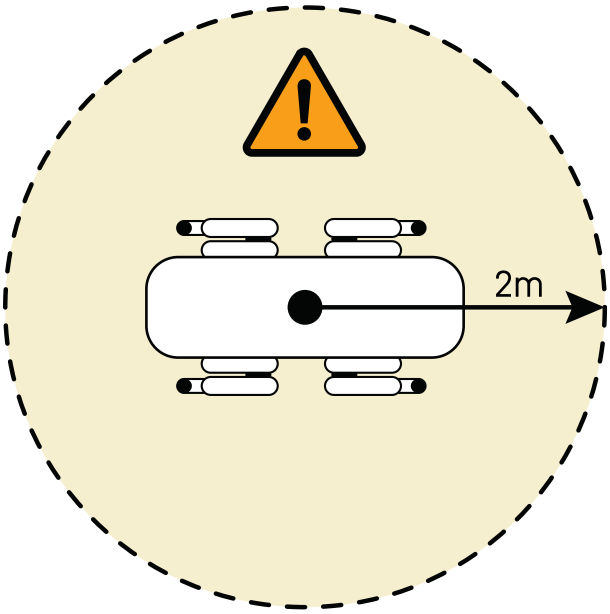


Figure 4 - Danger zone around the Robot

1.10 Noise levels

The Robot emits noise higher than C-weighted sound pressures of 63 Pa, up to 79.8 Pa in nominal conditions.

The Robot emits noise higher than 70 dB(A).

> **Notice**
>
> The noise level generated by the Robot depends on the work environment.
>
> For example, some floors can generate higher noise levels when being walked on.

1.11 Residual risks

The Robot incorporates the latest technology and complies with current safety requirements. Nevertheless, there are some residual risks that require your attention.

1.11.1 Pinch points

> **Warning**
>
> Crunching and pinching hazard from moving actuators and other parts of the Robot!
>
> Do not insert any body parts between Robot shank and thigh, or its torso and legs.
>
> This can cause serious injury when the Robot is operating.

> **Warning**
>
> While handling the Robot when it is unpowered, or it is being maintained, caution must be used around the pinch points of the Robot.

1.11.2 Sharp edges

> **Warning**
>
> Risk of injury from sharp edges!
>
> The Robot has some components with sharp edges.
>
> Be careful when handling the Robot and wear suitable gloves.

1.11.3 Hot surfaces

Warning

Risk of hot surfaces and burns!

- Do not touch surfaces that might be hot during, or immediately after, operation.
- Do not touch the actuator housings immediately after operation.
- Do not touch the main body or top plate in high ambient temperatures.
- Do not touch the heat sinks.
- Do not touch the inspection payload.

1.11.4 Laser

Warning

The LIDAR unit and depth cameras use a Class 1 Eye-safe per IEC 60825-1:2007 & 2014 laser.

Do not look directly at the transmitting laser.

The laser for the LIDAR unit and depth cameras are enclosed in protective housings. Do not tamper with, or disassemble the protective housings or lasers.

1.11.5 Electrical current

DANGER

Risk of death!

If the Robot is struck by lightning or a high electrical discharge, it must not be used.

Return the Robot to ANYbotics for full checks and servicing.

Warning

Risk of electrical shock or damage to equipment!

- Do not expose the electronics of the Robot, its battery, or battery charger.
- Ensure the voltage rating of the battery charger matches the standard outlet voltage at the operation site.
- Ensure the correct installation of battery charger and connection to a protected electrical network.
- Regularly inspect cables for damage and do not use if there is visible damage on the cables.
- Do not use the battery charger if the device shows signs of wear or mechanical damage.
- Do not use the batteries if they show signs of wear or mechanical damage.

1.11.6 Electromagnetic

Warning

ANYmal (gen. D) complies with the EN IEC 61000-6-4:2018 standard for electromagnetic emissions.

Before working with ANYmal (gen. D), confirm that your pacemaker is designed to work properly under these levels of electromagnetic emissions.

If you have any questions, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

1.11.7 Heavy Robot

The Robot weighs over 50 kg (110 lb). The Robot is transported using a Transport Box. This box contains the Robot and additional components, making it heavier than the overall Robot weight.

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Warning

Risk of injury when lifting the Robot!

- Always shut down the actuators before you approach the Robot.
- Always shut the Robot down before lifting it.
- Inspect the hoist points for signs of damage before attaching the carry handles.
- Always use the dedicated carry handles that are provided to lift the Robot.
- If possible use a mobile crane to lift the Robot.
- Do not stand underneath the Robot when it is lifted.

▶ *For more information, see "1.14 Lifting the Robot" on page 44*

Warning

Risk of injury from lifting the Robot!

- Always lift the Robot using at least two people. At least four people are needed when putting the Robot into or removing the Robot from the Transport Box.
- You must only use the lifting handles on the Robot.
- Observe correct posture and good lifting practices when lifting the Robot.

Warning

Risk of crushing or trapped hands!

Hands and fingers can get crushed or pinched between the Transport Box body and the lid.

Caution must be used when lowering or lifting the Robot into or out of the Transport Box.

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Warning

Risk of injury when lifting and moving the Transport Box!

- Always use the equipped wheels to move the Transport Box.
- When moving the Transport Box on slopes use brakes on the wheels.
- If possible use a forklift or a mobile crane to lift the Transport Box.
- Do not stand underneath the Transport Box when it is lifted.

1.11.8 Operating environment

Caution

Risk of unexpected behavior or movement!

- Loose objects lying on the floor can be propelled or knocked over by the Robot.
- Rope-like objects lying on the floor can get entangled in the Robot joints, for example, cables or flexible trunking.
- Very low temperature can impact the operation of the Robot joints.
- The operator may not see the indicator lights on the Robot when the Robot is operated in direct sunlight.

Some external factors may impact the operation of the Robot:

- Objects on the floor
- Temperature
- Moisture
- Vibration
- Electromagnetic radiation

Caution

Risk of data loss or damage to people and property!

Ensure that the operating area for the Robot does not include strong electromagnetic fields.

- Strong electromagnetic fields can damage the Robot systems and cause potential data loss.
- Strong electromagnetic fields can disturb communications with the Operator computer. This is not an issue when operating in autonomous mode.

▶ *For more information, see "12.1 Robot environmental specifications" on page 306*

1.11.9 Elevated platforms

Warning

Risk of injury when the Robot operates on an elevated platform!

- Guard rails on elevated platforms must be constructed to prevent the Robot from falling off the elevated platforms.
- Install signs around and underneath an elevated platform to warn from falling objects that could be dropped from the platform by the Robot.
- Wear a helmet when an elevated platform is part of the site where the Robot is to be used.

Warning

- Do not stand underneath the Robot when it operates on an elevated platform or stairs.
- Do not try to catch or break the fall of the Robot, if the Robot collapses.

Caution

Guard rails on elevated platforms must have a gap of no more than 0.3 m between horizontal rails, up to a height of at least 0.8 m.

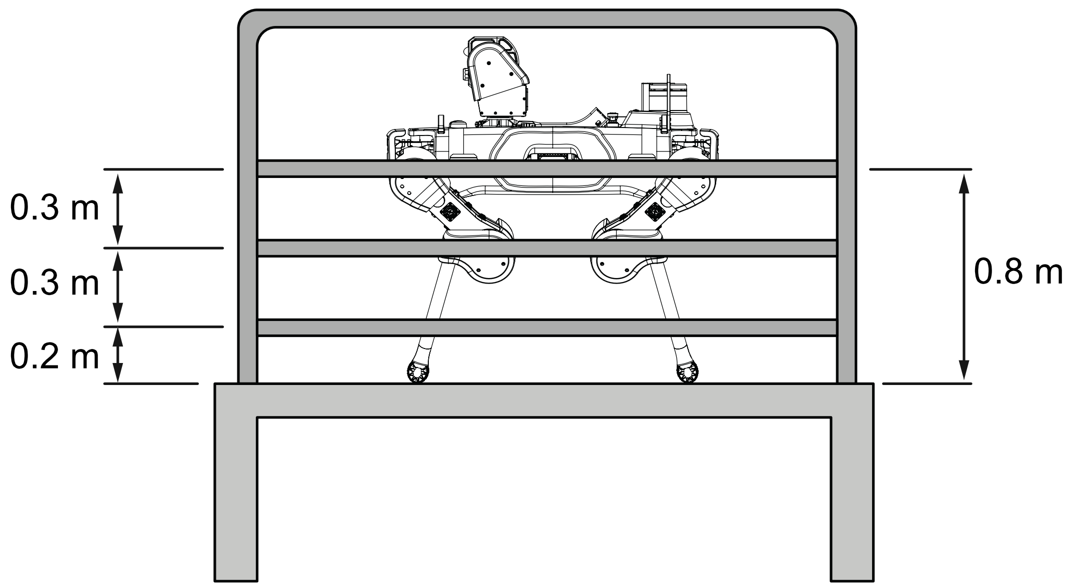


Figure 5 - Example of guard rail maximum gaps and minimum height

1.11.10 Sensors on the Robot

The Robot uses different sensors to perceive and interpret its environment. Disturbance to the sensors can cause the Robot to behave or move unexpectedly.

Caution

Risk of unexpected behavior or movement!

- Heavy precipitation can degrade the abilities of the Robot. Clean the sensors if necessary.
- Condensation can form on the sensors when the Robot moves between environments of different temperatures. Clean the sensors if necessary.
- Ice, dirt or mud on the sensors can degrade their performance. Clean the sensors if necessary.
- Sensors can be blinded by direct sunlight. Use caution when moving into sunlight or outdoor bright environments.
- Environmental vibrations or accelerations can disturb the sensors. Do not use the Robot in such environments as this can impact the accelerometers in the Robot.
- The sensors do not detect holes or gaps in the floor. Do not use the Robot in such environments.
- The sensors do not detect large bodies of water. Prevent access to these areas before operating the Robot.

1.11.11 Teleoperation

Warning

Risk of serious injury or death!

Stop the Robot immediately if you observe an imminent dangerous situation. Do not continue using the Robot until the dangerous situation has been cleared.

During teleoperation, operating the Robot without line of sight of the Robot, the operator must monitor the environment around the Robot using the Robot sensors. The front and back cameras provide visual feedback. Also the LIDAR unit and depth camera data can help to detect obstacles or people within the danger zone of Robot.

▶ *For more information, see "1.9 Safe operating area" on page 28*

1.11.12 Blind spots

The Robot is equipped with six depth cameras and a LIDAR unit used for collision avoidance and cliff detection.

The depth camera fields of view do not cover all of the Robot environment. There are small areas between the depth camera fields of view where the Robot may not be able to detect an obstacle or a cliff. The depth camera fields of view may also be obscured by the movement of the Robot legs.

The LIDAR unit field of view may be obscured by the inspection payload.

Data is filtered out of the sensor data that corresponds to the Robot legs, main torso, and the inspection payload. Anything behind the area covered by the legs or inspection payload are filtered out and will not be seen by the Robot. However, something that is not visible in front of the Robot by the LIDAR unit, due to blocking from the inspection payload, may be visible by the front depth cameras.

There are no sensors looking below the main torso of the Robot.

Some of the blind spots of the depth cameras are visible by the LIDAR unit but only from the height of the Robot. The vertical range of LIDAR unit is 15° from the horizon.

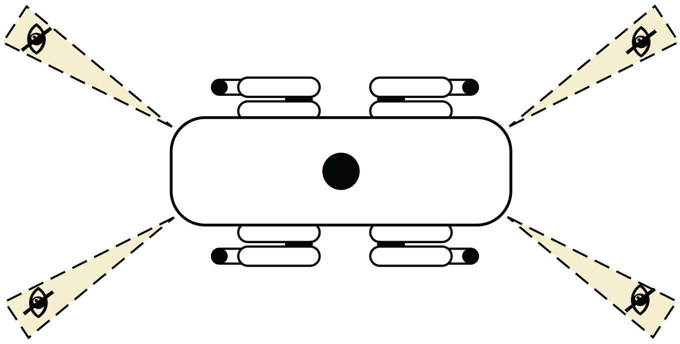


Figure 6 - Robot depth camera fields of view blind spots

1.11.13 Collision avoidance

Warning

Risk of serious injury or death!

Do not rely on the collision avoidance feature to prevent collisions, especially if the collision is with a person.

- The collision avoidance feature can be bypassed by an operator.
- The Robot cannot perceive ladders.
    - Do not perform on-site tasks, using ladders, while the Robot is operated in an area.
    - If ladders have to be used in the operating area of the Robot, ensure the ladders are secured from impact from the Robot.

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Caution

Risk of injury!

The collision avoidance feature stops the Robot in front of obstacles detected in the Robot path. However, this feature cannot be relied upon. The performance varies depending on the size, shape, material and texture of the obstacle’s surface.

Bright or shiny obstacles with reflections can be misinterpreted by the image analysis software.

Moving obstacles are also difficult to detect.

1.11.14 Cliff detection

Warning

Risk of serious injury or death!

It is not guaranteed that the Robot will always stop before a cliff.

- The cliff detection feature can be bypassed by an operator.
- During operating the ANYbotics Workforce app, the cliff detection behavior depends on the collision avoidance behavior selected.
- During autonomous operation, cliff detection only works if the **Stop-and-go** collision avoidance behavior is selected.

► *For more information, see "8.3.11 How to change collision avoidance behavior using the ANYbotics Workforce app" on page 222*

Caution

Risk of injury!

The cliff detection feature detects cliffs in the Robot path and stops the Robot in front of them. However, this feature cannot be relied upon.

The edge and bottom of the cliff must be visible to at least one of the Robot depth cameras. The cliff depth must be more than 100 mm and less than 2 m.

1.11.15 Network and data security

Notice

Please report security vulnerabilities on https://support.anybotics.com/.

Caution

Risk of data loss or damage to people and property!

- Observe network and data security and integrity in the facility according to industry standards and best practices.
- Perform an on site risk assessment with respect to the network and site data security requirements and the integration of the Robot for your specific target plant and area of operation.
- You must avoid any situations where you can lose control, and connection, with the Robot.
- Consult with ANYbotics AG before integrating any of your systems, or 3rd-party software, with ANYbotics systems.
- Ensure your systems are backed-up and supported with necessary data protection facilities, for example, remote data recovery services.

Caution

Risk of data loss or damage to people and property!

Ensure that the operating area for the Robot does not include strong electromagnetic fields.

- Strong electromagnetic fields can damage the Robot systems and cause potential data loss.
- Strong electromagnetic fields can disturb communications with the Operator computer. This is not an issue when operating in autonomous mode.

1.12 Battery

DANGER

Risk of death!

- Only use the batteries for their designated purpose.
- Do not connect any equipment to the terminals of the batteries that has not been cleared for use by ANYbotics AG.
- Never short-circuit the batteries.
- Never use damaged batteries. A damaged battery can overheat and start burning.
- Only charge the battery with the designated charging equipment.
- Never operate the Robot without the bottom shell covering the battery.

Warning

Risk of serious injury or death!

- Do not exert excessive force onto the battery.
- Do not drop the battery.
- Do not leave the battery unattended for extended periods of time during charging.
- Regularly inspect batteries during charging.

Warning

Risk of electrical shock!

Do not open the battery.

Warning

Risk of fire or flammable materials!

Do not expose the battery to excessive heat.

Warning

Risk of serious injury or death!

Follow these instructions for safe battery storage:

- Store the battery at room temperature.
- Store the battery charged to half its capacity.
- Store the battery in a dry environment.
- Store the battery in a flame retardant container.
- Store the battery separated from anything hazardous, for example, explosives, combustibles, or any other highly flammable material.
- Do not expose the battery to direct sunlight or other heat sources for extended periods.

Caution

Risk of injury!

Observe local regulations for use, transport and storage of Lithium-ion based batteries.

Do not insert or remove the battery when your Robot is connected to the battery charger. This can damage the battery.

Recycle batteries at the end of their lifetime according to local regulations.

1.13 Actuators

Warning

Risk of serious injury or death!

Do not block the movement of the actuators.

Do not apply high torques over an extended period to the actuators. This can damage the actuators.

Warning

Risk of hot surfaces!

Do not touch the actuators immediately after operation. The actuators can become hot.

Caution

Risk of injury!

The actuators are fast and powerful. Maintain a safe distance when testing new software.

► *For more information, see "1.9 Safe operating area" on page 28*

Caution

Risk of injury!

When a command has been received to enable the actuators, the actuators are only powered after 9 seconds have passed. This ensures that people who are still in the 2 m danger zone can either stop the power-up process or leave the danger zone.

Caution

Risk of injury!

If you are operating Robot on site, ensure that you warn bystanders before you power the actuators by loudly announcing: **Powering actuators**.

If the Robot is being operated remotely, people must be aware of the danger zone active warning light on the Robot.

All facility staff, including the Robot operators, must be trained to know that the danger zone active warning light must be monitored and a 2 m distance must be kept when it is on.

► *For more information, see "1.9 Safe operating area" on page 28*

1.14 Lifting the Robot

Warning

Risk of injury from lifting heavy objects!

If you need to lift the Robot, follow these guidelines:

- Ensure you use a crane or suspension system that is rated for at least 900 kg.
- Ensure connectors and ropes are also rated for that weight.
- When lifting the Robot with a crane, only use the four hoist points.
- When manually lifting the Robot, always use the carry handles attached to the hoist points.
- The Robot is heavy. Always use at least two people when lifting the Robot. Use four people when using the Transport Box.
- Observe correct posture and good lifting practices when lifting the Robot.

Caution

Risk of injury!

- Only lift the Robot when the actuators are not powered and the Robot is completely shut down.
- Inspect the hoist points for visual signs of wear and tear before attaching the carry handles. The hoist points can be damaged when the Robot falls.
- Do not use the hoist points when they appear to be damaged.
- If possible, use a mobile crane to lift the Robot.
- Always use the dedicated carry handles that are provided when manually lifting the Robot.
- Never insert your fingers into the carry handle attachment holes.
- Be careful around potential pinch points on the Robot, especially in the hip joint area and between the torso and the legs. The legs might move due to gravity.
- Do not stand below the Robot when it is lifted. Especially when using a mobile crane.

Caution

Risk of injury!

- Only suspend the Robot from the dedicated hoist points.
- Ensure that there is only tension and no torsion load on the hoist points.
- Ensure that only perpendicular forces are applied to the hoist points when lifting.

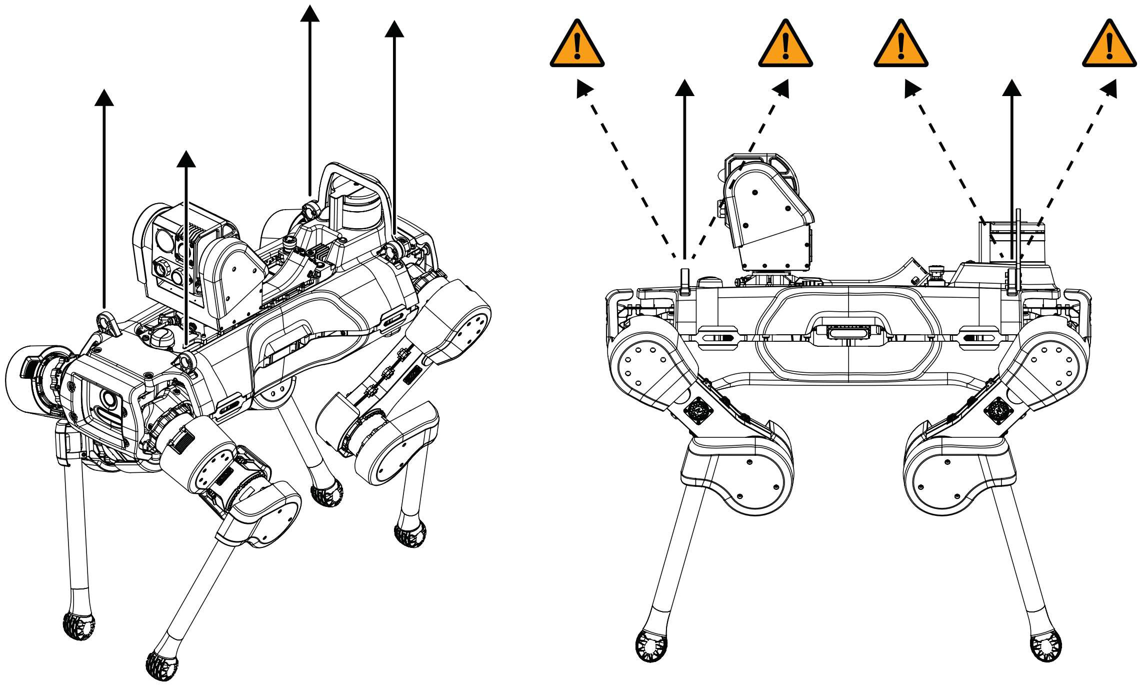


Figure 7 - Lifting the Robot

1.15 Stairs

Warning

Risk of serious injury or death!

The Robot may fall when using stairs.

- Do not stand below the Robot when the Robot is using stairs.
- Do not operate the Robot on stairs when people are on the stairs.
- Do not operate the Robot on stairs that are part of the plant or site evacuation routes.
- Do not approach stairs when the Robot is using them.

Warning

Risk of serious injury or death!

The Robot must be facing in the correct direction when walking up or down stairs.

- When walking up stairs, the front of the Robot must point to the top of the stairs.
- When walking down stairs, the rear of the Robot must point to the bottom of the stairs.

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Warning

- Do not stand underneath the Robot when it operates on an elevated platform or stairs.
- Do not try to catch or break the fall of the Robot, if the Robot collapses.

Caution

Risk of damage!

The Robot may fall if there is not enough power to use the stairs.

Ensure that the Robot has sufficient battery charge before attempting to use stairs or starting an autonomous mission which requires the Robot to use stairs.

Caution

Risk of damage!

The Robot may fall if it is stopped while using the stairs.

Do not stop the Robot while it is climbing stairs except in case of emergency.

Tip

ANYbotics recommends applying warning signs around your plant or site highlighting when the Robot uses a dedicated set of stairs on a regular basis.

1.16 Safety checks after a Robot fall

Caution

Risk of injury!

The Robot is designed to withstand a variety of fall scenarios. Nevertheless it can happen that parts of the Robot are damaged after it has fallen. Inspect the following points after each fall, to ensure it is safe to operate the Robot.

Before you power and start the Robot:

- Check the whole Robot for signs of mechanical damage.
  - The leg segments are not bent or damaged in other ways.
  - The inspection payload, if present, can move freely around its axes. Check by manually moving it.
  - Check the glasses of the sensors for mechanical damage.
  - Always check cameras, Lidar unit, and inspection payload sensors if present.
  - Inspect the hoist points for signs of wear and tear.
  - Inspect connections for any damage to the IP67 protective covers.
- Inspect the safety functions for correct functioning by performing the diagnostic tests.
  - ▶ *For more information, see "1.5 Safety functions" on page 20*

After powering the Robot:

- Check that the Robot walks as expected.
- Check that the inspection payload moves as expected.
- Do not continue operation if you discover any damage before the damage is repaired.
  If you are not sure about potential damage, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

1.17 Inspection payload (optional)

Warning

Risk of hot surfaces!

Do not touch surfaces that might be hot during, or immediately after, operation, for example the spotlight or camera.

Warning

Risk of crushing or trapped hands!

Do not touch the inspection payload when it is powered.

Risk of clamping around the axes of rotation of the inspection payload.

Warning

Risk from bright or intense light!

The inspection payload uses a very bright light source.

Do not look directly at this light source for prolonged periods of time.

Caution

Risk of injury!

The spotlight on the inspection payload is very bright.

- Do not look directly into the spotlight.
- Do not point the spotlight at others.

2 HARDWARE DESCRIPTION

To operate the Robot, you should be familiar with the descriptions of the machine parts and main systems.

> **Warning**
>
> You must read and be aware of all safety information before using the Robot.
>
> ► *For more information, see "1 Safety information" on page 16*

2.1 Overview

ANYmal (gen. D) is a four-legged ruggedised, water and dust-proof Robot, capable of moving and operating autonomously in challenging terrain while operating safely.

Its four legs allow the Robot to crawl, walk, run, climb, carry – whatever motion the task requires.

The Robot uses a LIDAR unit and depth cameras to perceive its environment. It can record a map of the environment and find its position within this map with the help of the localization and mapping software.

For outdoor operation, the Robot is protected to IP67 standards against water and dust ingress to allow operation in harsh conditions.

The Robot has extreme mobility using four legs containing three actuators for each leg, giving its flexible and fast locomotion on a wide variety of terrain.

Onboard batteries give the Robot long operational endurance.

Payloads can be installed and integrated on the Robot, allowing it to complete a wide variety of tasks.

2.2 Dimensions

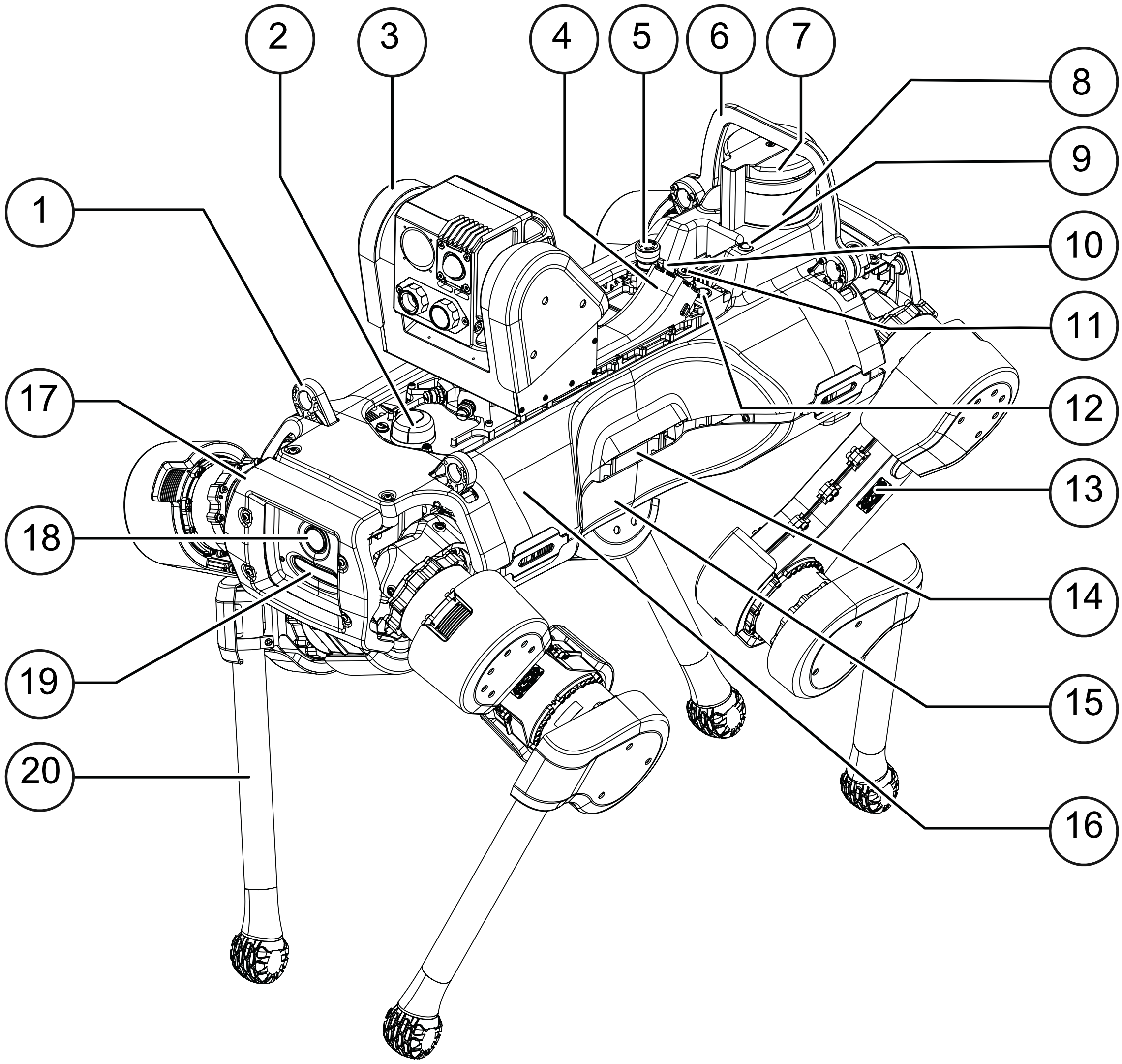
The Robot has the following dimensions:

Table 1 - Robot specifications

Size lying L x W x H	942 x 663 x 450 mm
Size standing L x W x H	886 x 540 x 908 mm
Weight	■ Including docking socket, no battery - 45.0 kg ■ Including docking socket and battery - 50.6 kg ■ Including docking socket, battery, inspection payload - 56.3 kg
Maximum walking speed	1.3 m/s

2.3 Main parts

Before operating the Robot you should be familiar with the location and names of all parts of the Robot. This will help you understand the operating procedures and assist with troubleshooting, if required.



1	Hoist points (4)	Used to lift the Robot. Minimum two person lift. Always use the lifting handles provided.
2	Wi-Fi antenna	Used for communicating with the Robot when in autonomous mode of operation.
3	Inspection payload	Supplied fitted to the Robot. Used to gather inspection data.
4	Computer cooling fan	Used to cool the internal operating systems of the Robot. Do not block this fan.
5	Emergency stop	Used to stop the Robot in the event of an emergency. ► *For more information, see "1.5.1 Robot emergency stop" on page 21*
6	Rollover bar	Used to prevent damage to the LIDAR unit if the Robot falls.
7	Danger zone active warning light and diagnostic lights	Used to indicate the different warning and diagnostic states of the Robot.
8	LIDAR unit (light detection and ranging unit)	Used as part of the Robot navigation and movement system.

9	Status light	Shows the current status of the Robot systems.
10	Ethernet socket	Provides direct access to the internal network of the Robot.
11	Battery charging socket	Used to charge the battery while it is fitted in the Robot.
12	Power button	Used to power the Robot on and off.
13	Leg cooling fan (8)	Used to cool the leg actuators. There are 2 cooling fans on each of the 4 legs.
14	Depth camera, one each side of the Robot	Used to provide navigation and movement information for the Robot.
15	Bottom shell	Used to protect the under-side of the Robot and the battery. Do not operate the Robot without the bottom shell fitted.
16	Top shell	Used to protect the top-side of the Robot.
17	Front and rear shells	Used to protect the ends of the Robot.
18	Wide angle camera	Used to provide navigation and movement information for the Robot.
19	Depth camera, two at front and two at rear of Robot	Used to provide navigation and movement information for the Robot.
20	Legs (4)	Used to move the Robot.

Figure 8 - Location of the main Robot parts

2.3.1 Power button

The Robot power button starts and shuts down the Robot.

The power button is located on top of the Robot.

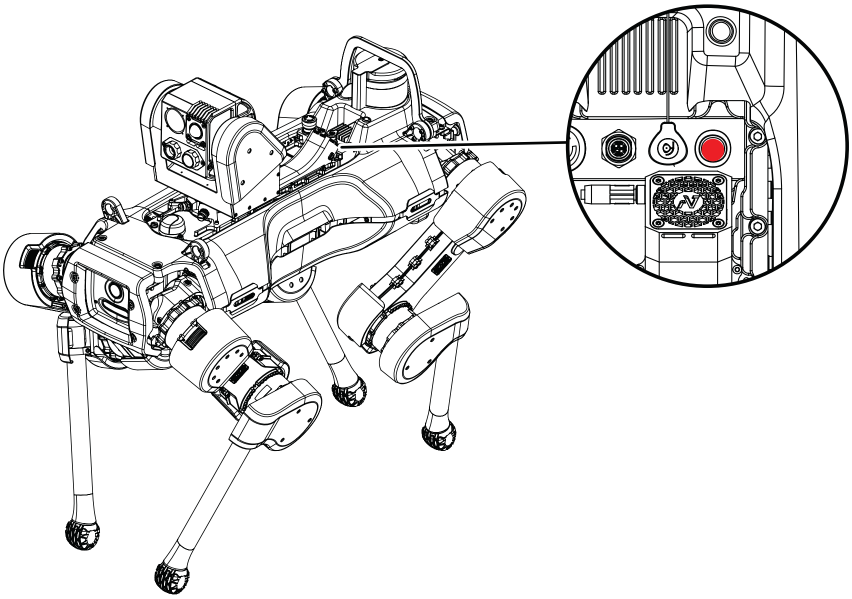


Figure 9 - Location of the Robot power button

2.3.2 Connections

The connections are located on top of the Robot and on the side of inspection payload.

> **Notice**
>
> The connection sockets are rated to IP67. To prevent water ingress you must use the socket caps or an IP67 compliant cable.

> **Notice**
>
> Exceeding current limits of connectors can damage the Robot.
>
> Before connecting external devices to the Robot, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/

The connections include:

- Charging socket
  The charging socket can be used to charge the battery in the Robot.

> **Caution**
>
> Do not operate the Robot without the battery fitted.

- Ethernet socket
  The Ethernet socket provides direct access to the internal network of the Robot. This can be useful when the wireless connection is not available or when network bandwidth is limited. The Ethernet socket is situated on the top of the Robot.
- USB socket
  The USB socket is used for providing power and a data link for external resources and equipment.
- RS-232 socket (on the inspection payload)
  The RS-232 socket is used for serial communication and connecting peripheral devices to the inspection payload.
- RS-485 socket (on the inspection payload)
  The RS-485 socket is used for serial communication and connecting peripheral devices to the inspection payload.
- Additional power connector
  This is located next to the antenna at the front of the Robot. It provides power for any additional equipment fitted to the Robot.

2.3.3 Handles

Warning

Risk of injury from lifting heavy objects!

- Only use the handles supplied.
- Do not try to lift the Robot with less than four of the handles attached.
- Do not try to lift the Robot if the handle strap or hoist points appear damaged or worn.
- The handles must not be used for any other purpose than for lifting the Robot.

The Robot is equipped with four hoist points, two in the front and two in the back. These can be used to carry the Robot manually by using a provided set of handles.

To lift the Robot, using the handles:

1. Insert the strap through the hoist points.
2. Loop the strap over the handle.
3. Pull the handle to tighten the strap.
4. Repeat for all hoist points.

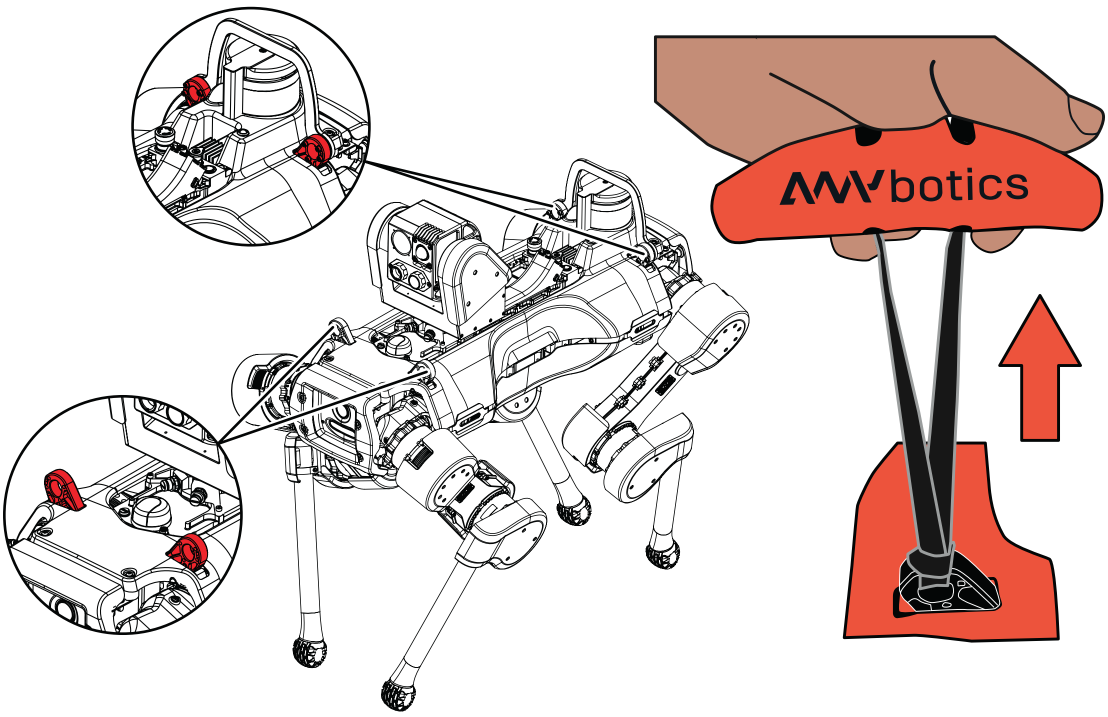


Figure 10 - Location of the Robot hoist points and handle with straps

▶ *For more information, see "1.14 Lifting the Robot" on page 44*

2.3.4 Sensors

The Robot has the following sensors to perceive its current state and the state of its surroundings.

- Inertial measurement unit (inside the Robot)
- Depth cameras
- Wide angle camera
- Lidar unit

The sensors measure the following information:

- Position and orientation of the Robot
- Position and orientation of the leg segments
- Terrain, objects, and obstacles around the Robot
- Velocity of the Robot
- Velocity of the leg segments
- Torques of the joints

The inputs of these sensors are acquired and processed by the Robot software. The Robot includes internal sensors, for example, pressure, temperature, and humidity detection.

2.3.5 Danger zone active warning light

The danger zone active warning light is located on the top of the Lidar unit.

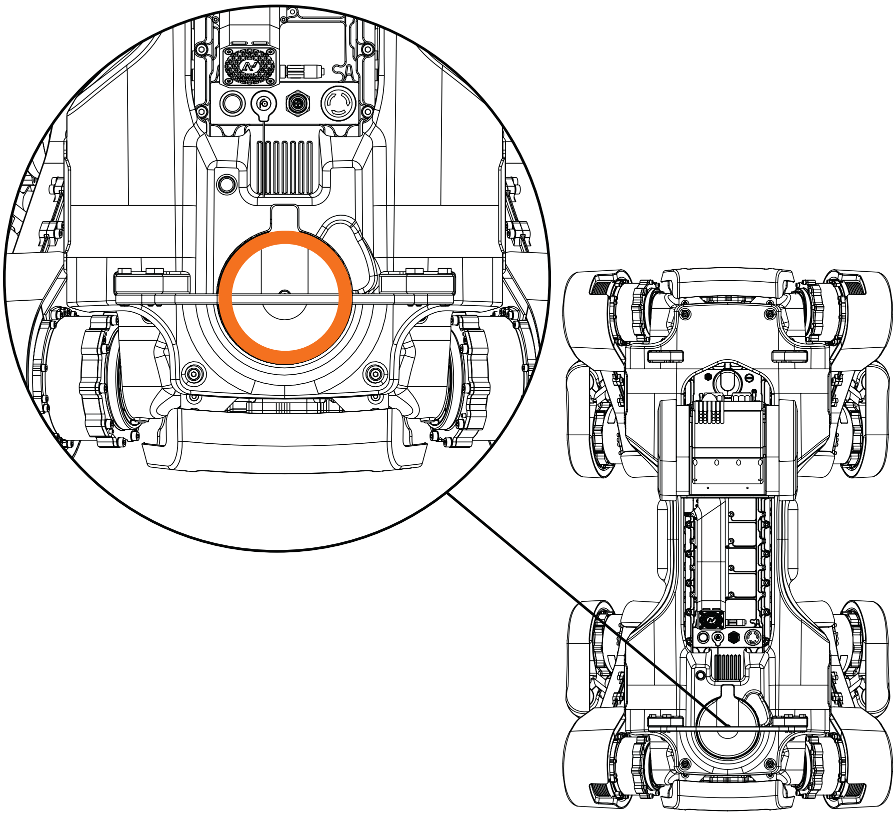


Figure 11 - Danger zone active warning light location

The danger zone active warning light (orange light) is on when a command has been issued to enable the actuators.

All Bystanders must then either leave the danger zone or prevent the power up process if they cannot leave the danger zone by activating one of the emergency stops on the Robot.

After a time period of nine seconds has passed, the actuators are activated.

The danger zone active warning light is off when the actuators are powered down. This can happen from a command to disable the actuators or from activation of the emergency stops (e-stops).

2.3.6 Diagnostic lights

The diagnostic lights are located on top of the Lidar unit, inside the Danger zone active warning light.

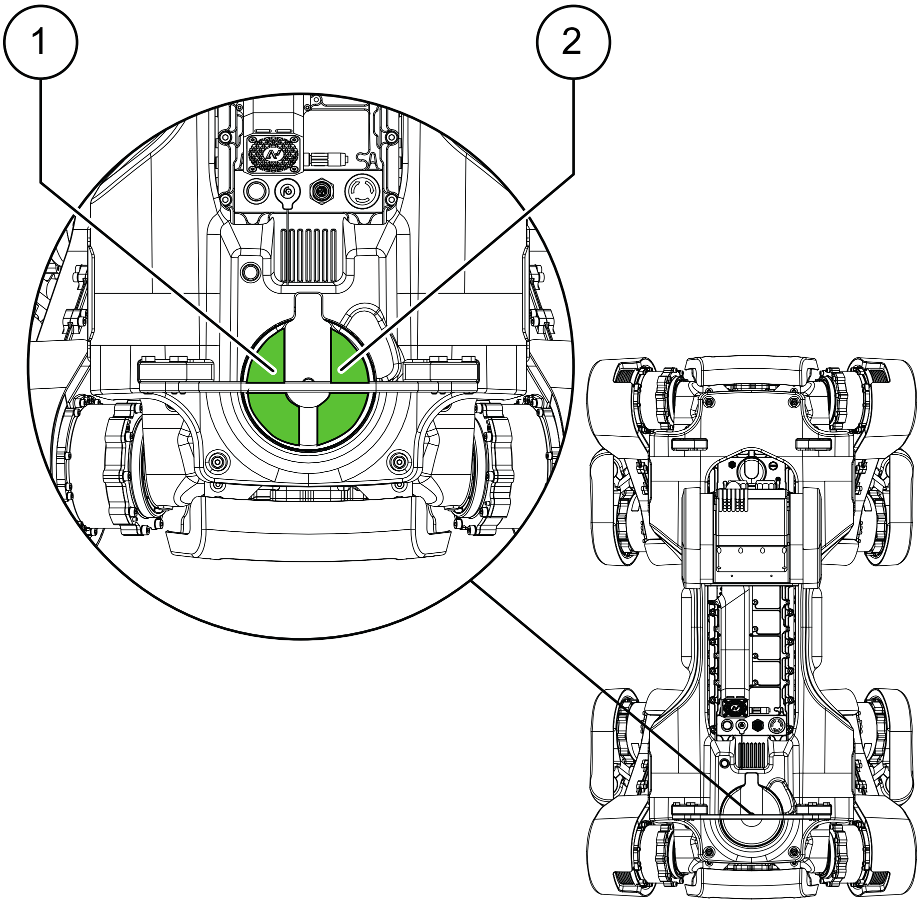
These lights are used to provide information when testing the safety functions.

► *For more information, see "10.2.1 Safety functions" on page 277*

These lights are not used during normal operation of the Robot.

Notice

The diagnostic lights can be on during normal operation of the Robot, but have no significance for normal operation.



1	Left side diagnostic light
2	Right side diagnostic light

Figure 12 - Location of diagnostic lights

Table 2 - Diagnostic light sequences and states

	Green - ON	Green - OFF
Robot e-stop diagnostic light 1 (Left side)	Robot emergency stop is engaged.	Robot emergency stop is disengaged.
Remote control e-stop diagnostic light 2 (Right side)	■ GUI cut power is engaged. OR ■ No drive-enable request present. OR ■ GUI cut power is disengaged. and ■ Drive-enable request received. and ■ Delayed start is running.	■ GUI cut power is disengaged. and ■ Drive enable request received. and ■ Delayed start has passed.

2.3.7 Status light

The status light is an RGB indicator light on the top shell of the Robot next to the power button.

The status light indicates the current operational mode to the Operator and whether an activity is in progress.

Table 3 - General meaning of status light colors

Red	Fault or critical error
Amber	Warning or action failure
Green	Operational or in good condition
White	Background process running or switching mode

Table 4 - Status light states and what they mean

Red, solid	■ An error occurred that can stop the Robot from operating.
Amber, solid	■ The ANYbotics Workforce app or GUI cut power was engaged ■ The protective stop was engaged.
Amber, pulsing	■ The docking procedure has failed. ■ An error occurred while the Robot was executing a mission.
Green, solid	■ The Robot is ready for input.
Green, pulsing (slow)	■ The Robot is sleeping or charging on the docking station.
Green, pulsing	■ The Robot is performing an autonomous mission.
White, solid	■ The Robot is on.
White, blinking (fast)	■ The Robot is powering up.
White, blinking	■ actuators are powering up.
White, pulsing	■ The Robot is shutting down. ■ The Robot is switching to an operational mode.

2.3.8 Computers

The Robot has two onboard computers:

- Locomotion computer (LPC)
- Navigation computer (NPC)

Each of them provides computational power to a specific set of skills of the Robot. The computers are connected through the internal network of the Robot using a switch.

▶ *For more information, see "12.3 Computer specifications" on page 307*

2.3.8.1 Locomotion computer

The locomotion computer (LPC) coordinates and hosts the software modules related to motion control. It communicates with the PDB and the actuators.

The LPC is connected to the:

- Inertial measurement unit
- Front and rear depth cameras

2.3.8.2 Navigation computer

The navigation computer (NPC) hosts the software modules related to path planning and path following.

The NPC is connected to the:

- Wide angle cameras
- LIDAR unit
- Side depth cameras

2.3.9 Wi-Fi antenna and router

The Robot is equipped with a Wi-Fi antenna and router.

You can use it as an access point to wirelessly connect your computer to the Robot. You can also connect the Robot to an existing wireless network.

Supported Wi-Fi interfaces are:

- Wi-Fi: 802.11a/b/g/n/ac, MIMO 2T2R, 2.4/5 GHz

2.3.10 Heat sinks and fans

The Robot is equipped with two heat sinks and nine fans, which allow regulation of the temperature.

The Robot has heat sinks situated in the following locations:

- On top of the Robot, running between the battery charging socket and the base of the inspection payload, covered by a funnel.
- On the inspection payload.

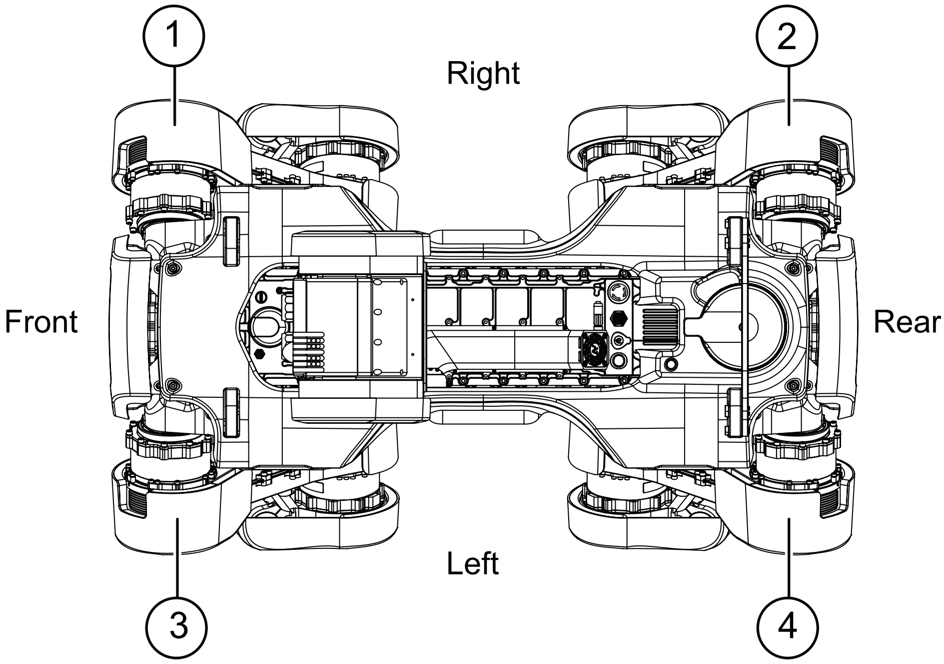
The Robot has fans situated in the following locations:

- Legs on the either side of the thigh element.
- Top of the Robot next to the power button.

2.3.11 Legs

The Robot has four legs that use actuators for moving.

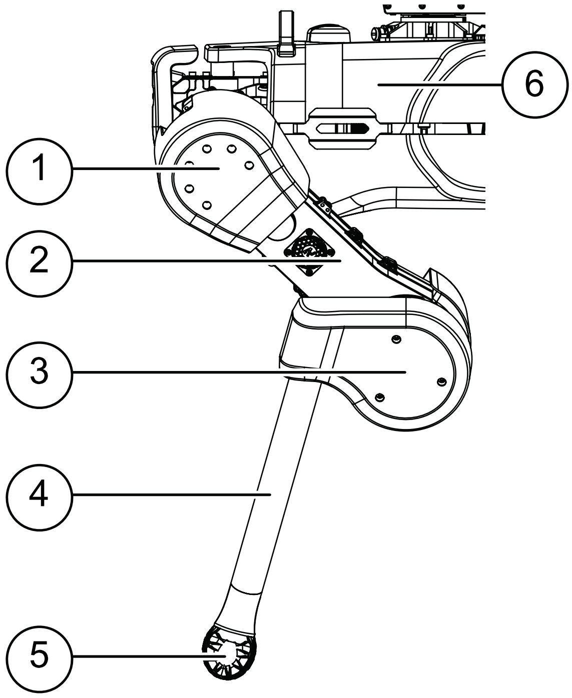
The front legs are located next to the inspection payload and the rear (hind) legs are located next to the LIDAR unit. Leg identification can be abbreviated using the following definitions.



1	RF: right front
2	RH: right hind
3	LF: left front
4	LH: left hind

Figure 13 - Names of legs of the Robot

Each leg can be divided into parts.



1	Hip	Contains two actuators providing tilt and rotational movement.
2	Thigh	Contains two cooling fans for the leg actuators.
3	Knee	Contains one actuator proving step motion for the leg.
4	Shank	Fixed metal tube.
5	Foot	A flexible rubberised pad providing grip on a wide range of surfaces. If this part is damaged, it can be replaced by the operator.
6	Torso	A collective term used for the body of the Robot where the legs are attached.

Figure 14 - Names of leg parts

2.3.12 Protectors and shells

The Robot is equipped with protectors and shells to prevent it from damage while on a mission.

The protectors are attached to the legs of the Robot to protect the actuators:

- Hips
- Knees

The shells are attached to the torso of the Robot and consist of the following parts:

- Top
- Bottom
- Front
- Back

The top, front and back shells must not be removed unless they are damaged and need replaced.

The bottom shell is removable to exchange a battery.

2.3.13 Actuators

Actuators are motors responsible for controlling and moving the Robot. The actuators are located at each joint of the leg.

The actuators and their motions are identified as follows:

- HAA: hip abduction/adduction
- HFE: hip flexion/extension
- KFE: knee flexion/extension

Notice

The hip joint contains important power lines and cables.

You should not rotate the hip joint through more than 360°.

2.3.14 LIDAR unit

Warning

The LIDAR unit and depth cameras use a Class 1 Eye-safe per IEC 60825-1:2007 & 2014 laser.

Do not look directly at the transmitting laser.

The laser for the LIDAR unit and depth cameras are enclosed in protective housings. Do not tamper with, or disassemble the protective housings or lasers.

The Robot is equipped with a LIDAR unit. The LIDAR unit is situated on top of the Robot.

The LIDAR unit uses lasers to ping off objects around the Robot to measure distance and map the environment.

Notice

The field of view of the LIDAR unit can be restricted, towards the front of the Robot, by the inspection payload.

This leads to blind spots of the LIDAR unit in front of the Robot when the inspection payload is mounted.

The LIDAR unit is protected by a rollover bar.

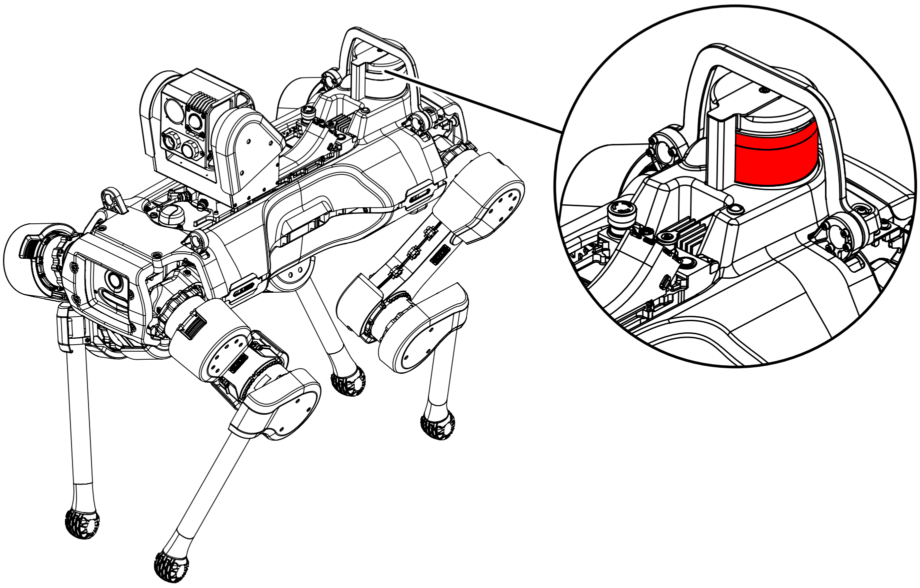


Figure 15 - Location of the LIDAR unit on the Robot

2.3.15 Depth cameras

Warning

Risk from injury from laser!

The depth cameras contain and use an infrared (IR) projector.

- Do not power on the Robot if any external damage is observed. The depth cameras must be returned to the manufacturer for servicing or replacement.
- Do not attempt to open any portion of the laser component.
- Avoid direct exposure to beam.
- There are no user serviceable parts with this laser component.
- Modification or service of the stereo module, specifically the infrared projector, may cause the emissions to exceed Class 1.
- No magnifying optical elements, such as eye loupes and magnifiers, are allowed.
- Do not try to update camera firmware that is not officially released for specific depth camera module and revision.

The Robot is equipped with six depth cameras:

- Two at the sides of the Robot
- Two at the front of the Robot
- Two at the back of the Robot

These cameras use IR projectors as part of the range detection capabilities.

The cameras are used by the Robot for obstacle avoidance and autonomous navigation.

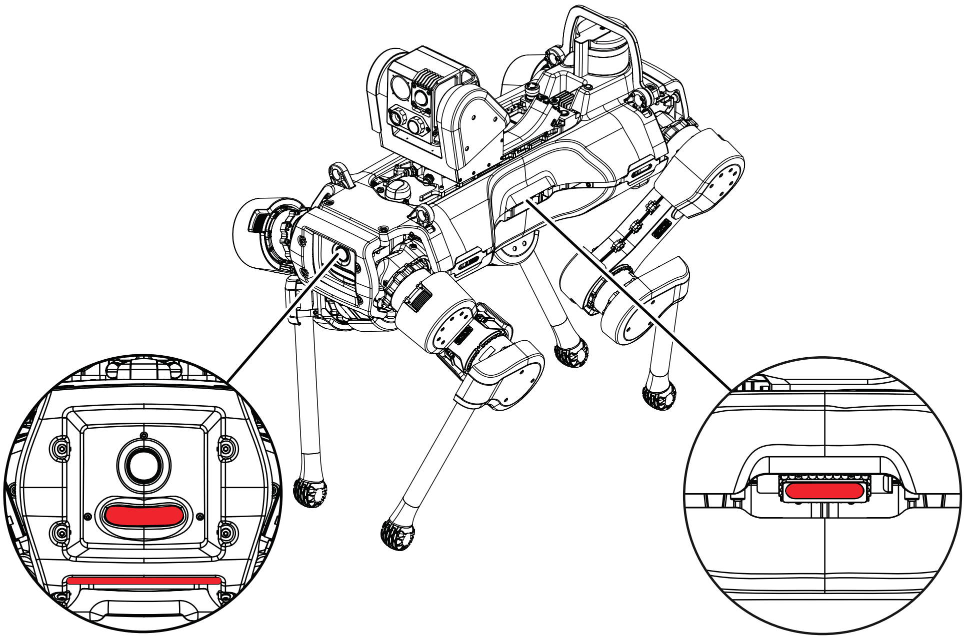


Figure 16 - Location of the depth cameras

2.3.16 Wide angle camera

The Robot has two wide angle cameras mounted in the front and back. The cameras stream color images. The cameras provide a view of the area around the Robot.

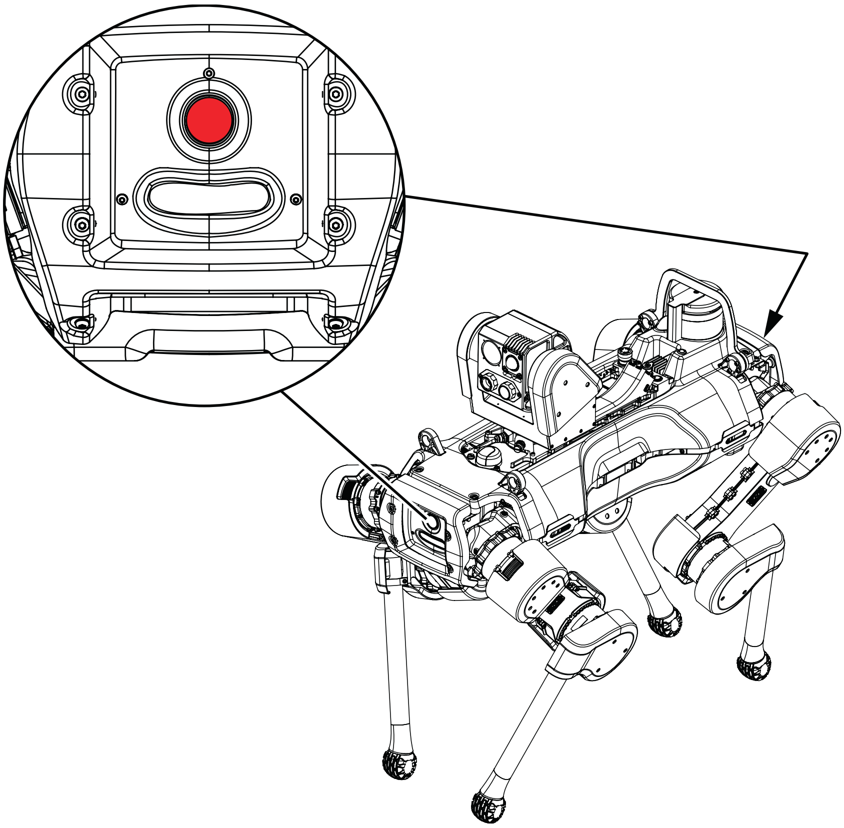


Figure 17 - Location of the wide angle cameras

2.3.17 Battery

The Robot is powered by a swappable battery composed of Lithium-ion based cells. The battery is designed to endure all relevant load cases during the intended use of the Robot and has passed UN 38.3 transportation tests.

The battery must only be used with the Robot. The battery is situated under the Robot and is protected by the bottom shell. The battery is securely attached to the Robot using brackets and screws.

The battery can be charged using the following methods:

- In the Robot using the charging socket
- Outside the Robot using the battery charger
- Automatically with the docking station and docking socket

Notice

The battery cannot be charged if it is too hot. The battery needs to cool down before charging can start. You are notified of the charging state in the operator GUI.

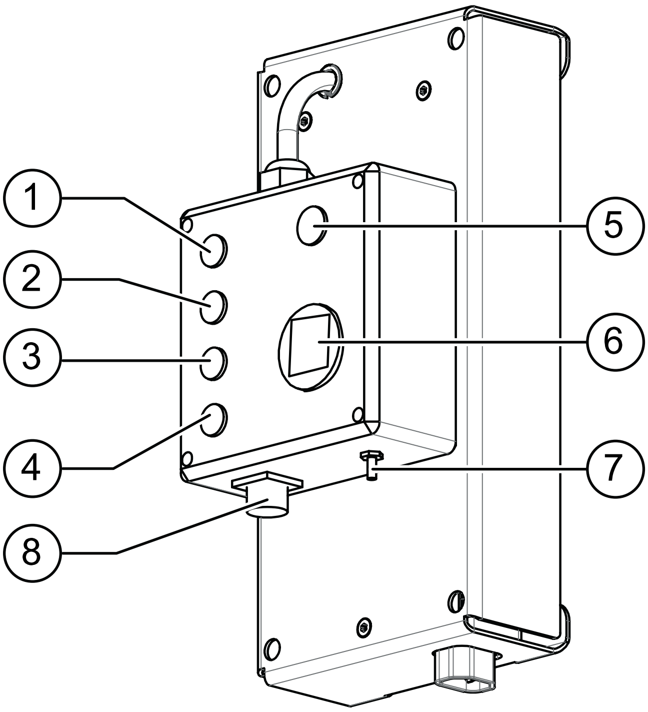
> **Notice**
> The battery is shipped with a 30% charge and must be charged before the first use.

> **Notice**
> Lithium-ion based batteries are subject to special regulations when transported. Regulations require these batteries to be inserted into the device, or to be packed in 4G UN boxes.
>
> Ensure compliance with any additional regulations concerning Lithium-ion based batteries that may apply.

2.3.18 Battery charger and adapter

The battery charger is supplied with the Robot. It charges the battery using a charging cable attached directly to the Robot.

The battery charger can be mounted indoors and outdoors. However, if fitted outdoors the battery charger needs to have protection against water ingress.



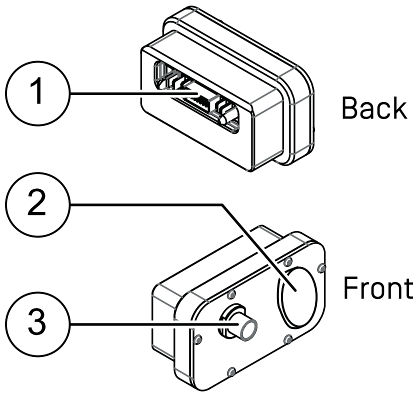
1	Full charge indicator	Indicates when the battery has a full charge.
2	Charging and/or power delivery indicator	Indicates that the battery is being charged. The charging light and the full charge light can be on at the same time. This indicates that the battery is completely or almost full and that the Robot is using power from the charger.

3	Connected indicator	Indicates the battery charger is connected to the Robot.
4	Power indicator	Indicates that the battery charger is turned on.
5	Force charge button	If the battery is fully discharged, the battery goes into a deep sleep state. Use this button to force charging of the battery.
6	Voltage charge level	Displays the voltage of the battery.
7	Power switch	Turn on or off the battery charger.
8	Charging cable socket	Connection for the power cable used for charging. Ensure the protective cover is fitted when not in use.

Figure 18 - Components of the battery charger

The battery adapter attaches to the battery, when it is not in the Robot, and lets you charge the battery externally using the battery charger.

► *For more information, see "8.1.3 How to charge the Robot battery externally" on page 198*



1	Battery socket	Used to connect to the battery
2	Voltage charge level	Displays the voltage of the battery
3	Power connection	Used to connect the adapter to the battery charger

Figure 19 - Battery adapter

2.3.19 Autonomous charging system

The autonomous charging system autonomously charges the battery. The autonomous charging system can be permanently installed in locations that best suit your inspection requirements.

The autonomous charging system consists of the following components:

- Docking station
- Docking socket

2.3.19.1 Docking station

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The docking station should be installed on site to allow the Robot to charge autonomously. The charging is done by the connector cone on the docking station that fits into the docking socket on the Robot.

The rings and AprilTags enable the Robot to identify and localize the docking station.

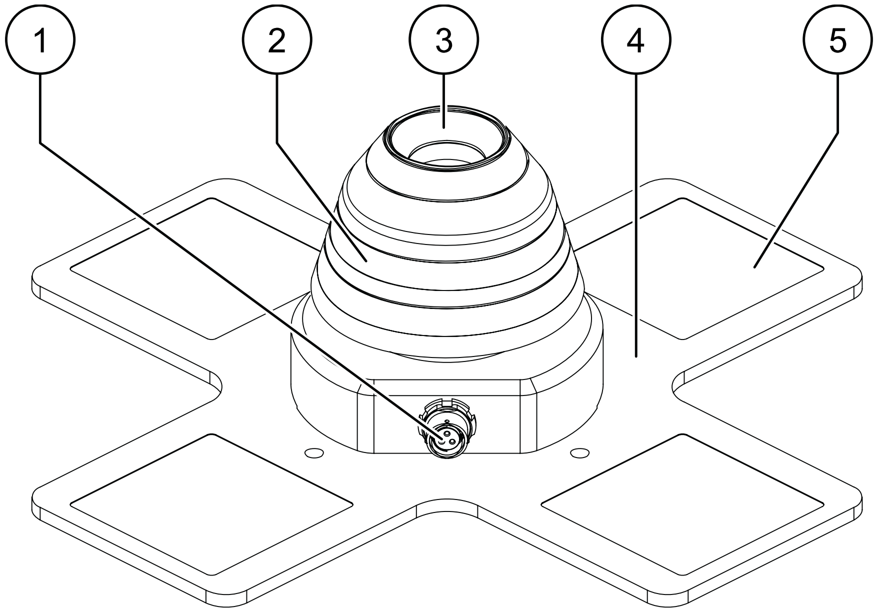
Notice

Locate the docking station in an area with sufficient lighting. The Robot needs light to identify and locate the docking station.

Locate the docking station in a dry environment whenever possible. The docking station should not be located where water can pool.

Do not locate the docking station in an area that could impact the safety of personnel, for example, near a fire exit.

Do not locate the docking station in direct sunlight. This prevents the degradation of Robot and docking station components due to UV light exposure.



1	Charging cable socket	Used to provide power to the docking station.
2	Connector cone	Used to engage with the docking socket.
3	Rings	Used for power connection. Includes a sensor for detecting the presense of the Robot.
4	Base	Used to secure the docking station to the floor.
5	AprilTag	Used for providing identification and positioning information for the Robot.

Figure 20 - Components of the battery charger

2.3.19.2 Docking socket

The docking socket is located on the front bottom side of the Robot. The charging is done by the connector cone on the docking station that fits into the docking socket on the Robot.

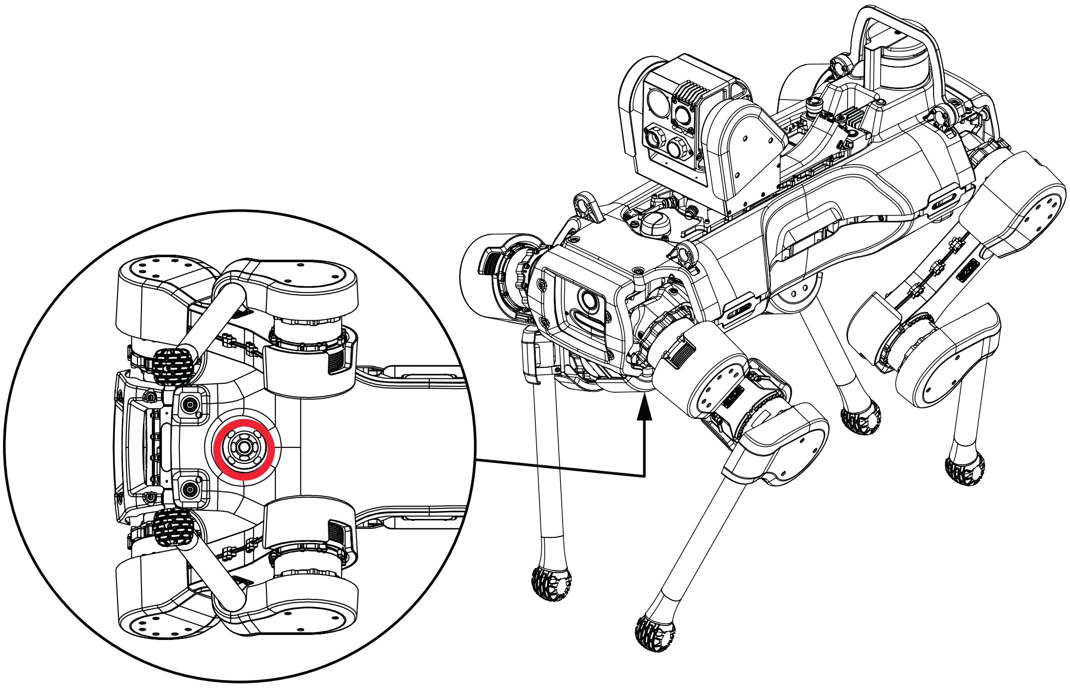


Figure 21 - The docking socket installed on the Robot

> **Notice**
> The autonomous charging system may not work reliably if the docking socket is dirty.

2.3.20 Transport Box

The Transport Box is used to safely transport and store the Robot. The Transport Box has dedicated compartments for all components of the Robot to protect them during storage and transport.

► *For more information, see "12.12 Transport Box specifications" on page 311*

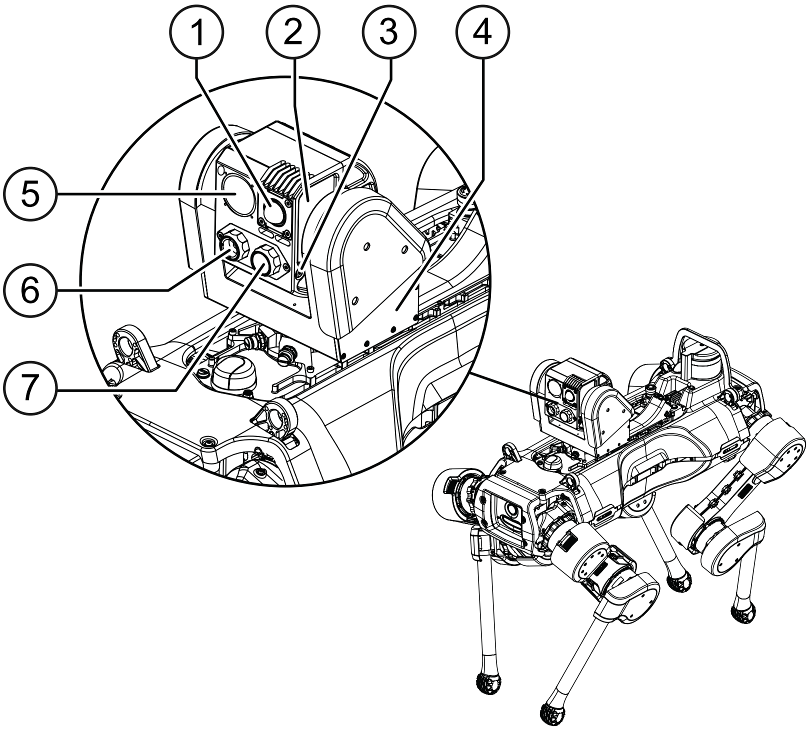
2.3.21 Inspection payload

The inspection payload integrates several sensors with the Robot. The sensors are mounted on a pan-tilt unit so that the Robot can direct its sensors. The inspection payload is mounted on top of the Robot.

The inspection payload has connectors for integrating additional sensors.

The inspection payload allows you to perform:

- Visual inspection
- Thermal inspection
- Auditory inspection



1	Spotlight	Used to light inspection areas. Do not look directly at this light while in operation.
2	Tilt unit	Used to tilt the inspection payload.
3	Pressure relief valve	Used to relieve pressure from inside the inspection payload when transporting the Robot in pressurized transport, for example, aeroplanes.
4	Pan unit	Used to rotate the inspection payload.
5	Zoom camera	Used for capturing high quality images.
6	Thermal camera	Used for capturing thermal images.
7	Ultra-sonic microphone	Used to record high frequency sounds.

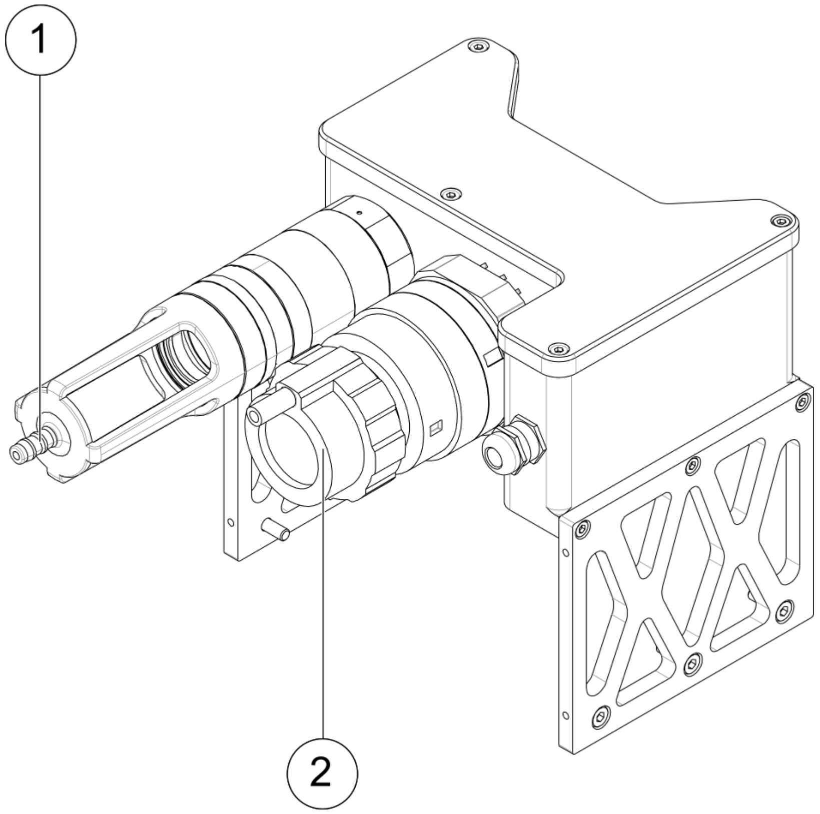
Figure 22 - Inspection payload

2.3.22 Gas sensing inspection payload

The gas sensing payload integrates several gas sensors with the Robot, which allow you to perform continuous and discrete gas inspection.

The gas sensing payload detects:

- Combustible gases, such as CH_4, C_3H_8, C_2H_4
- Toxic gases, such as H_2S, O_2, CO, Cl_2, NH_3, H_2, NO, NO_2, SO_2



1	Combustible gas sensor	Used to detect potentially hazardous concentrations of hydrocarbons.
2	Toxic gas sensor	Used to detect concentrations of toxic gases.

Figure 23 - Gas sensing inspection payload

3 SOFTWARE DESCRIPTION

The Robot is controlled by different software modules running on its onboard computers.

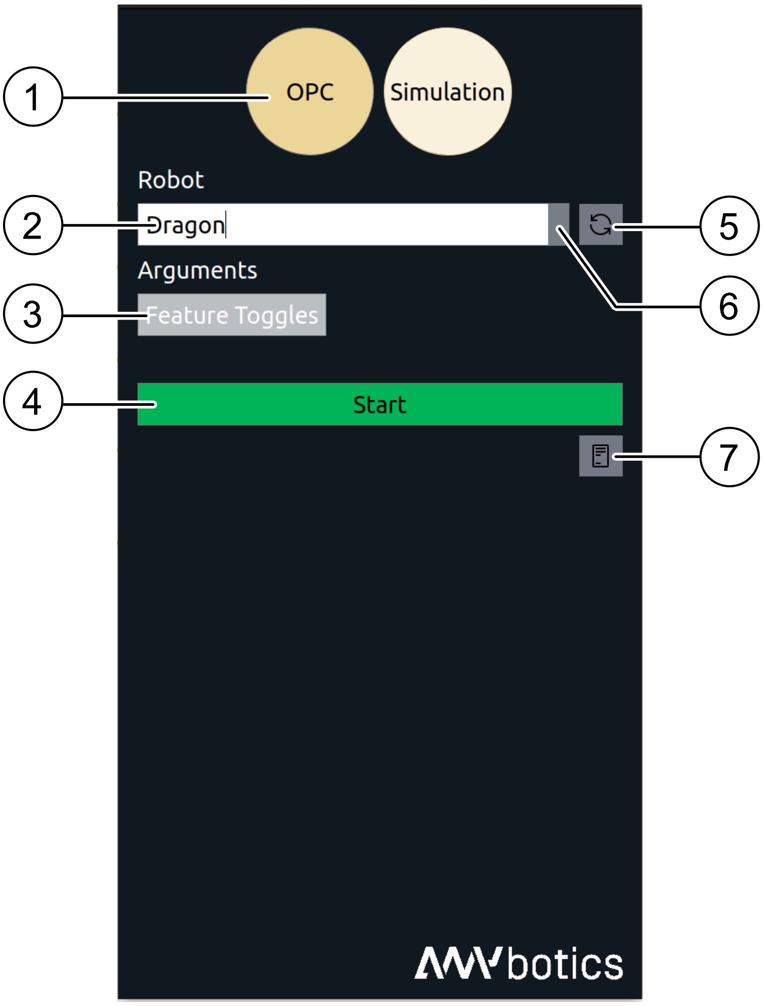
An operator graphical user interface (GUI) is provided to interact with the Robot.

▶ *For more information, refer to the ANYbotics Software Guide.*

3.1 Software launcher

The ANYmal software launcher serves as a common entry point to run the ANYmal (gen. D) operator computer or Simulation software.

Select **OPC** to start the operator graphical user interface (GUI).



1	Used to select the operator graphical user interface (GUI).
2	Name of the Robot.

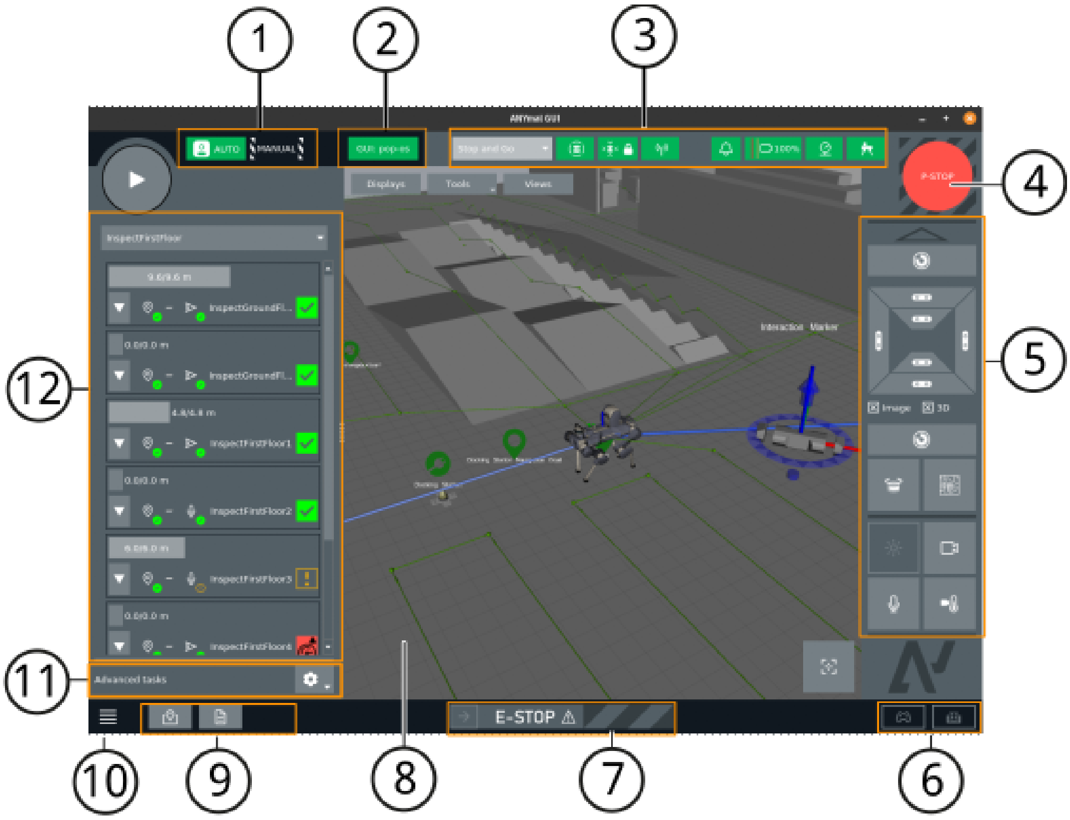
3	A disabled option.
4	Used to start and stop the software.
5	Used to discover all Robots on the network.
6	Used to show a list of Robots in the network.
7	Used to show or hide the log console.

Figure 24 - The ANYmal software launcher

3.2 Operator graphical user interface (GUI) overview

The operator GUI lets you operate the Robot, visualize data and monitor the state and health of the Robot.

The operator GUI is launched by selecting **OPC** from the software launcher.



1	User interaction mode panel	Shows the current user interaction mode (autonomous or manual) and lets the Operator switch between them.
2	Control authority panel	Shows who is currently controlling the Robot and lets the Operator take and release control.
3	Robot status panel	Shows an overview of the Robot status and provides access to additional menus. For example, to launch localization and mapping or check CPU temperatures.

4	Protective stop button	Used to trigger a protective stop. ► *For more information, see "8.5.1 How to activate the protective stop using the operator GUI" on page 232*
5	Sensor panel	Gives the Operator access to stream and record sensor data.
6	Robot control panel	Contains tools to control the motion of the Robot and the inspection payload.
7	GUI cut power slider	Used to immediately stop the Robot.
8	3D Visualization	Shows a visualization of the ANYmal work environment and controls what information is displayed.
9	Data management panel	Gives the Operator access to create and manage the ANYmal work environment and the data the Robot collects during missions.
10	Menu button	Opens a menu with applications to edit the ANYmal work environment and tools for advanced monitoring and control.
11	Advanced mission tasks	Used to view advanced mission tasks.
12	Mission panel	Used to select and run autonomous missions.

Figure 25 - Overview of the ANYmal software GUI

3.2.1 User interaction mode panel

The **User interaction mode** panel shows the current user interaction mode (autonomous or manual) and enables the Operator to switch between them.

► *For more information, see "8.2 How to manage control of the Robot" on page 200*

3.2.2 Control authority panel

The **Control authority** panel shows who is currently in control of the Robot and allows the operator to take and release control.

► *For more information, see "8.2.3 How to manage control of the Robot using the GUI" on page 202*

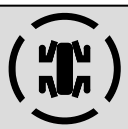
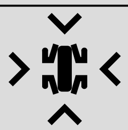
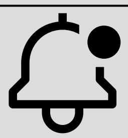
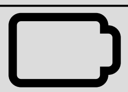
3.2.3 Robot status panel

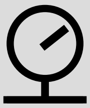
The **Robot status** panel shows an overview of the status of your Robot. The status indicators use the following color scheme:

Table 5 - Robot status indicator lights

Green	Everything is fine.
Blue	Everything is fine, the Robot requests your input.
Yellow	Warning, the Robot is operational but might require your attention. For example, if an obstacle or cliff is detected.
Red	Error, the Robot is not operational and requires your attention.

Table 6 - Status indicators

	Surrounding	Shows if there is an obstacle or cliff in the Robot path. The label changes to yellow and displays **Obstacle** when an obstacle is in the Robot path.
	Localization	If the Robot is not localized, this indicator is yellow. Select the indicator to open the **localization and mapping** panel.
	Communication	If the Robot has lost its connection to your operator computer, this indicator is yellow with a diagonal line through the icon.
	Notifications	If the Robot requests your input, this indicator is blue with a dot on the icon. Select the indicator to open the most recent notification.
	Battery	Shows the current state of charge of the Robot. There are two thresholds: ■ Yellow indicates that the battery is low. ■ Red indicates that the battery is critically low.

	Differential pressure	Shows the current differential pressure of the Robot in millibars (mbar). ■ If the differential pressure indicator is yellow, bring the Robot back to the safe zone. ■ If the differential pressure indicator is red, the Robot returns to the safe zone automatically.
	Robot	Shows the current Robot status: ■ Yellow indicates a warning status. ■ Red indicates an error status. Select the indicator to change the operational mode of the Robot and view warnings.
	Collision avoidance switch	Shows the current collision avoidance behavior of the Robot: ■ **Blind** ■ **Stop-and-go** Select one of the options to change the collision avoidance behavior. ▶ *For more information, see "8.5.20 How to change the collision avoidance behavior using the GUI" on page 250*

3.2.3.1 Diagnostics and health monitoring

The Robot also monitors its health and warns the user about issues.

If the Robot status changes, you can notice it by the color of the  button:

- Yellow indicates a warning status.
- Red indicates an error status.

▶ *For more information, see "3.2.3 Robot status panel" on page 78*

If you select the  button, the **Robot** window opens, which has the following functions:

- The **Diagnostics** tab shows warnings and errors about computer monitoring.
  - Processor or memory usage too high
    - ▶ *For more information, see "9.10 Processor or memory usage too high" on page 268*
  - Disk usage too high
    - ▶ *For more information, see "9.3 Disk usage too high" on page 263*
  - Network usage too high

    - ▶ *For more information, see "9.6 Network usage too high for onboard computers" on page 266*
    - ▶ *For more information, see "9.7 Network usage too high for the operator computer" on page 267*
  - Time sync offset too big
    - ▶ *For more information, see "9.14 Time information of the Robot is wrong" on page 272*
- The **Health Monitoring** tab shows warnings and errors about ingress detection and temperature monitoring.
  - Ingress detection
    - ▶ *For more information, see "9.16 Water inside the Robot" on page 274*
  - Temperature monitoring
    - ▶ *For more information, see "9.12 Robot temperature too high" on page 270*

3.2.4 Sensor panel

The **Sensor** panel gives access to stream and record sensor data including the wide angle cameras, depth cameras and the Lidar unit.

If the Robot is equipped with an inspection payload, the panel shows the zoom camera, thermal camera, ultra-sonic microphone and spotlight controls.

Select a sensor to stream recorded data. The streamed data is visualized depending on the sensor type:

- 3D data is shown in the **3D Visualization** panel (Lidar unit, depth cameras).
- Video streams are shown in dialogs (wide angle cameras, depth cameras, zoom camera and thermal camera).
- The audio stream is shown as a frequency diagram (ultra-sonic microphone).
- The explosive and toxic gas levels are shown as 2-D plots (gas sensor).

The dialog of the inspection payload zoom camera is interactive.

Select a point in the **3D Visualization** to center the camera around the selected point.

Draw a frame to center and zoom into the region of interest.

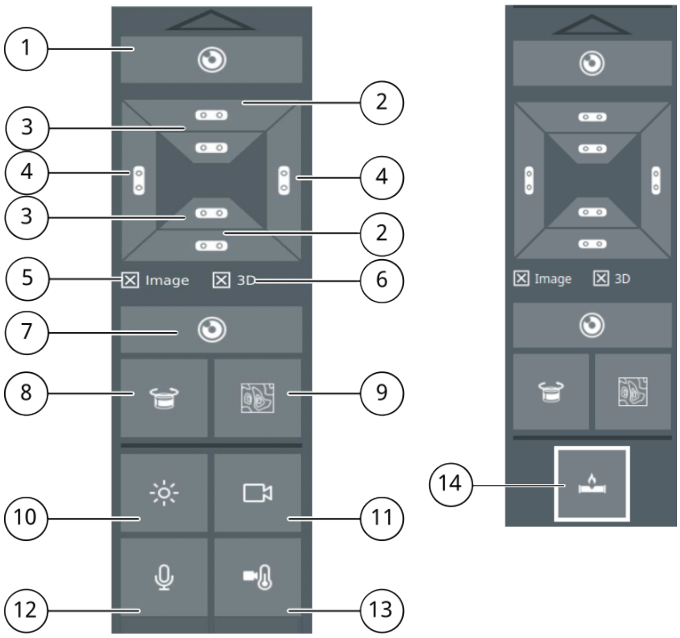
Notice

Note that the 3D data shown in this case is a filtered version of the raw data. You can access the raw data through the **Displays** panel.

Notice

Visualizing many sensors at the same time requires a lot of bandwidth. This can result in the GUI and/or visualization being very slow to render.

If connected to the Robot using a wireless network, ANYbotics recommends to only enable the visualization of sensor data when needed to save network bandwidth.



1	Front wide angle camera	Opens/closes the video feed window from the front wide angle camera.
2	Front/rear upper depth cameras	Turns the front/rear upper depth cameras on/off.
3	Front/rear lower depth cameras	Turns the front/rear lower depth cameras on/off.
4	Left/right depth cameras	Turns the left/right depth cameras on/off.
5	**Image** check box	Turns the image for the depth cameras on/off.
6	**3D** check box	Turns the 3D points for the depth cameras on/off.
7	Rear wide angle camera	Opens/closes the video stream window from the rear wide angle camera.
8	Elevation map	Displays/hides the elevation map. The elevation map is a local 2.5D map which contains the elevation of

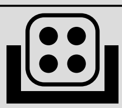
		the local terrain around the Robot.
9	Lidar unit	Turns the LIDAR unit on/off.
10	Spotlight	Opens/closes the spotlight brightness window.
11	Zoom camera	Opens/closes the video stream window from the zoom camera.
12	Ultra-sonic microphone	Opens/closes the ultra-sonic microphone window.
13	Thermal camera	Opens/closes the thermal camera window.
14	Gas sensor	Opens/closes the Gas sensor window.

Figure 26 - Overview of the ***Sensor*** *panel*

3.2.5 Robot control panel

The **Robot Control** panel contains tools used to directly control the Robot and inspection payload motions.

Table 7 - List of control panel tools

	Robot joypad	Used to steer the Robot. If the operational mode is **walk**, Robot joypad commands are translated into velocity commands. If the operational mode is **stand**, Robot joypad commands are translated into main body posture commands. - The left **Robot joypad** generates heading and lateral velocities respectively pitch and roll angles. - The right **Robot joypad** generates yaw velocities, yaw angles and height commands. - Double click on the Robot joypad to reset it.
	Payload joypad	Used to steer the Robot inspection payload. Control the pan and tilt angles, either by moving the cursor around, or double clicking to one of the nine pre-defined positions.

3.2.6 GUI cut power slider

Warning

Danger due to collapsing!

When the GUI cut power is activated, the Robot collapses.

Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the GUI cut power is activated on stairs.

When engaging the GUI cut power, stand clear and keep all limbs away from the Robot. After engaging the GUI cut power, the Robot collapses and there is a crushing hazard.

Warning

Risk of serious injury or death!

When the GUI cut power is activated, the following happens:

- The Actuators are no longer supplied with power.
- The Robot collapses.

The GUI cut power does not disconnect power to the following:

- Computers on the robot.
- Sensors.

The GUI cut power slider is located at the bottom center of the operator GUI.

► *For more information, see "3.2 Operator graphical user interface (GUI) overview" on page 76*

Activating the GUI cut power has the same effect as using the ANYbotics Workforce app cut power.

Notice

The GUI cut power is implemented and tested carefully but does not comply with ISO EN 13849-1.

3.2.7 3D Visualization panel

The **3D Visualization** panel shows the current position of the Robot in the work environment. The 3D Visualization panel has the following controls:

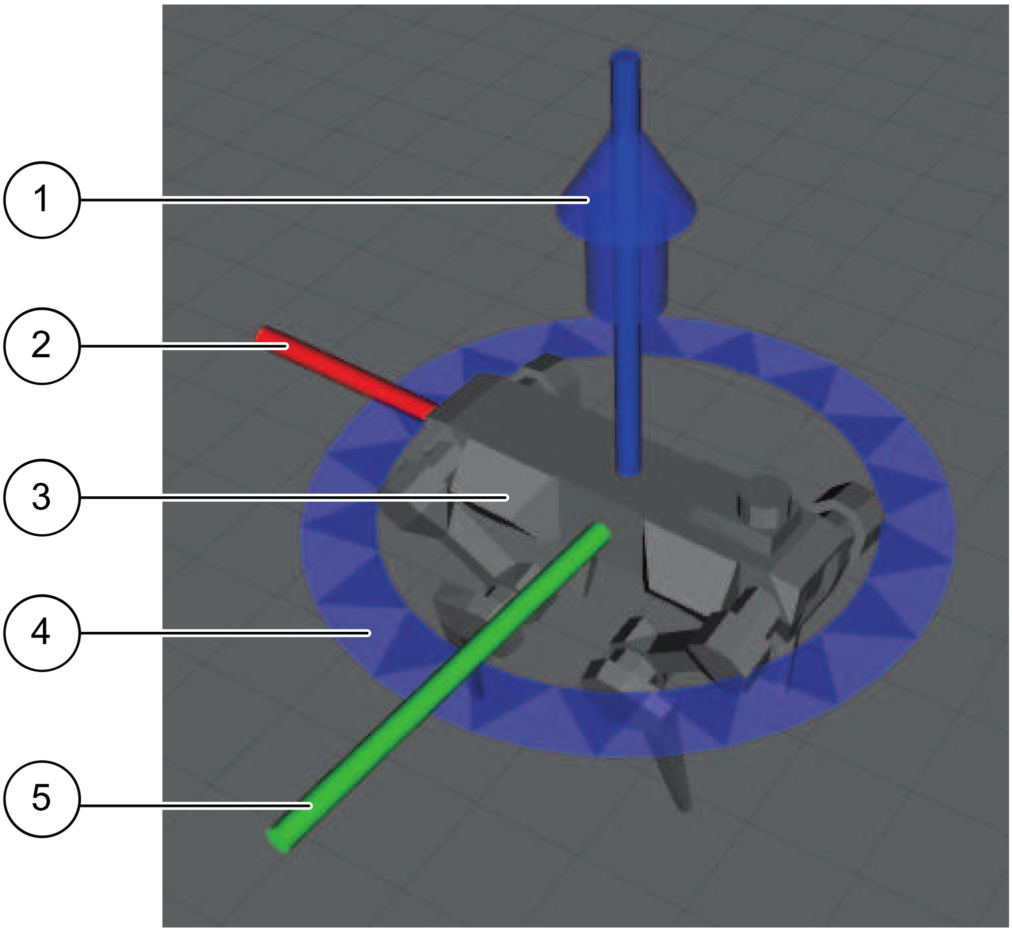
- Select **Displays** to configure the content of the 3D visualization.
- Select **Tools** to open a list of tools which can be used to interact with the 3D visualization.

- Select **Views** to open the camera configuration panel which can be used to switch between different camera perspectives and customize camera views.

From the 3D Visualization panel, you can move the camera view and select interactive objects such as navigation goals, inspection items and the interaction marker.

3.2.7.1 Interaction marker

A user can interact with the Robot and the Operation environment using the interaction marker. The interaction marker represents a simplified Robot with a coordinate system at its center .



1	The blue marker indicates the Z axis. The marker has two blue arrows that allow adjustment of the height of the marker. You can left click on the arrow and hold while moving the mouse to adjust the height.
2	The red marker indicates the X axis. The position of the red marker is considered to be the front of the Robot.
3	Representation of the Robot
4	Left click the blue ring of the interaction marker and hold while moving the mouse to drag the interaction marker around (pan) or rotate it around its blue axis.
5	The green marker indicates the Y axis.

Figure 27 - The interaction marker is used to interact with the Robot

Right-click on the interaction marker to open a menu of actions. The available actions in the menu of the interaction marker depend on the installed software modules.

Table 8 - List of standard actions

Reset marker	You can reset the marker to the current Robot position.
Set localization initial guess	You can give the Robot an initial guess of where it is located within the map. This will help the Robot to localize itself based on the received sensor input and loaded map.
Plan Path to Here (Straight Line)	Plans a path from the current Robot position to the interaction marker in a straight line. The path is visualized in the **3D Visualization**. No command is sent to the Robot to follow the path.
Plan Path to Here (Along Waypoints)	Plans a path from the current Robot position to the interaction marker following user defined waypoints.. The path is visualized in the **3D Visualization**. No command is sent to the Robot to follow the path.
Go Here (Straight Line)	Plans a path from the current Robot position to the interaction marker in a straight line. A command is sent to the Robot to follow the path. Warning Risk of serious injury or death! The **Go here (Straight Line)** feature must not be used for climbing stairs or in areas where the Robot may fall. For example, if cliffs are in the work environment. Only use this feature on flat terrain over distances less than 3 m.
Go Here (Along Waypoints)	Plans a path from the current Robot position to the interaction marker following user defined waypoints. A command is sent to the Robot to follow the path.
Take Picture	With the inspection payload installed, take a picture of a point of interest using the zoom camera.
Take Thermal Picture	With the inspection payload installed, take a picture of a point of interest using the thermal camera.
Record Zoom Camera Video	With the inspection payload installed, take a 10-second long static video recording of a point of interest using the zoom camera.
Record Thermal Camera Video	With the inspection payload installed, take a 10-second long static video recording of a point of interest using the thermal camera.

Record Wide-Angle Front Camera Video	With the inspection payload installed, take a 10-second long static video recording of the frontal Wide-Angle camera from the current position of the Robot.
Record Wide-Angle Rear Camera Video	With the inspection payload installed, take a 10-second long static video recording of the rear Wide-Angle camera from the current position of the Robot.
Toggle publish point cloud	Publish LIDAR point cloud data from the interaction marker position. This action can be used to to provide a manual initial guess for localization if automatic place recognition fails.

3.2.7.2 Environment objects

Within the work environment, there are objects that the Robot can interact with. On the **3D Visualization** panel, these environment objects are represented by the icons.

Right-click on any environment object to perform an action relevant to that object. For example, you can right-click on a Navigation goal object and choose **Go Here** to send the Robot to that location.

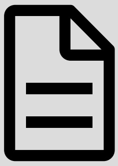
Table 9 - Environment object icons

	Navigation goal	Defines a pose for the Robot to navigate to.
	Docking station	Defines the location of the docking station.
	Simple inspection point (visual, auditory)	Defines a general visual or auditory inspection point.
	Dial inspection point	Defines a dial inspection point.
	Thermal inspection point	Defines a thermal inspection point.
	Static video recording inspection point	Defines a static video recording inspection point.

3.2.8 Data management panel

The data management panel provides access to the data that the Robot collects during missions.

Table 10 - Data management panel

	Environment panel	Used to manage the ANYmal work environment.
	Report panel	Used to view the history of Robot actions and events.
	Data Sync panel	Used to synchronize data to and from the Robot.Used to steer the Robot. After a mission, use the **Data Sync** system to copy the report the Robot created, including the collected data, to your computer. Data about the work environment is stored in environment data packages which can be uploaded to, and downloaded from the Robot.

3.2.8.1 Data synchronization

The data synchronization panel provides a convenient solution to bring an environment data package onto the Robot, receive reports and recordings from the Robot and download logs and system configuration files from the Robot.

- The **Environment** panel is used to manage the ANYmal work environment.
- The **Connection** widget is used to input connection details.
- The **Task** widget shows the current task running and its progress.
- The **Tabs** widget shows the different data synchronization options:
  - The **Data Package** tab is used to synchronize data packages between the Robot and the operator computer.
  - The **Report** tab is used to download a report or recordings from the Robot.
  - The **Logs** tab is used to upload logs from the Robot to the server and download logs from the server to the operator computer.

3.2.9 Menu panel

The **Menu** panel contains applications used to edit the Robot work environment and advanced tools for monitoring and control.

Table 11 - List of applications available to edit the work environment

Mission Editor	Used to create and edit missions within the current Robot work environment.
Environment Editor	Used to create and edit points of interest for navigation and inspection within the current Robot work environment.
Waypoints Editor	Used to create and edit waypoints.
Localization and Mapping Maps Merger	Used to merge Localization and Mapping maps from multiple sessions into single units.
Localization and Mapping Maps Transformer	Used to align Localization and Mapping maps to arbitrary reference frames.

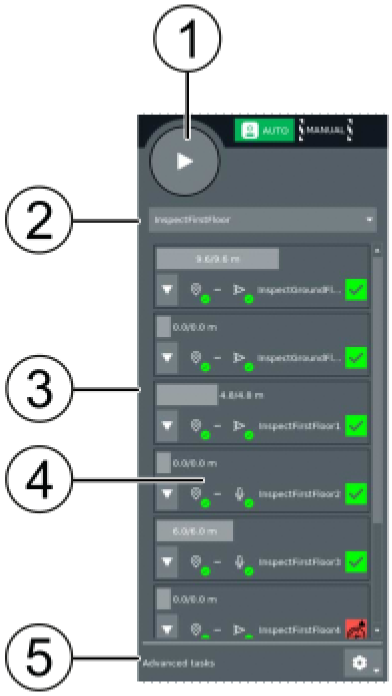
Table 12 - List of advanced tools available for monitoring and control

Motion Control	Used to select specific motion states or transitions.
Advanced Robot Status	Used to monitor the status of the Robot.
Low-Level Control	Used to interact with all actuators at the same time.
Actuators	Used to monitor and control individual actuators.
Power System	Used to monitor the power system and the status of various electric components inside the Robot.
Simulation	In simulation, used to pause or control the simulation.

3.2.10 Mission panel

The **Mission** panel is used to control autonomous missions.

▶ *For more information, see "8.5.6 How to start a mission using the GUI" on page 235*

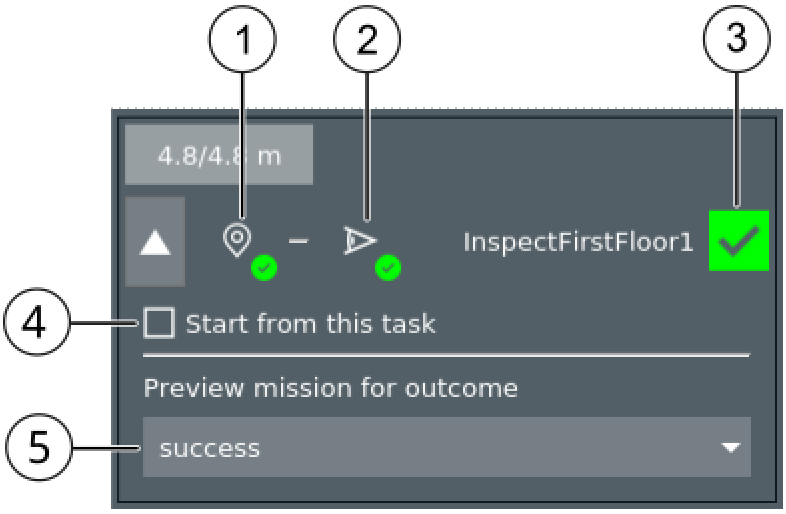


1	Start or pause	Starts or pauses the mission.
2	Mission selector	Selects the type of mission.
3	Task list	Shows tasks for the selected mission.
4	Navigation process panel	Shows an overview of the mission task. ▶ *For more information, see "3.2.10.1 Task progress panel" on page 91*
5	Advanced tasks	Shows advanced (single mission) tasks.

Figure 28 - Mission panel

3.2.10.1 Task progress panel

The task progress panel gives you an overview of the process options for a mission task.



1	First step	Shows the first step in the process. For example, a navigation step. The step status is displayed next to the step symbol. ▶ *For more information, see "3.2.10.2 Step status" on page 92*
2	Second step	Shows the second step in the process. For example, a visual inspection step. The step status is displayed next to the step symbol. ▶ *For more information, see "3.2.10.2 Step status" on page 92*
3	Overall task status	Shows the task status, and updates as the mission progresses. ▶ *For more information, see "3.2.10.3 Task status" on page 92*
4	Start from this task	Used to start a mission from a specific task.
5	Preview mission for outcome	Used to preview the mission with a different task outcome.

Figure 29 - Task progress panel

3.2.10.2 Step status

The step status gives you information about the current status or outcome of a step.

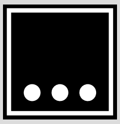
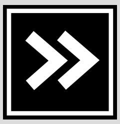
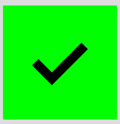
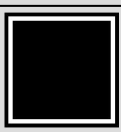
Table 13 - Step status indicators

	Step pre-empted/paused	Shows the step was pre-empted or paused. For example, the Operator paused the mission, or the Robot had a failure and stopped the mission.
	Step successful	Shows the step was completed successfully.
	Step unsuccessful	Shows the step was unsuccessful. For example, the navigation goal could not be reached, or the pressure could not be read.

3.2.10.3 Task status

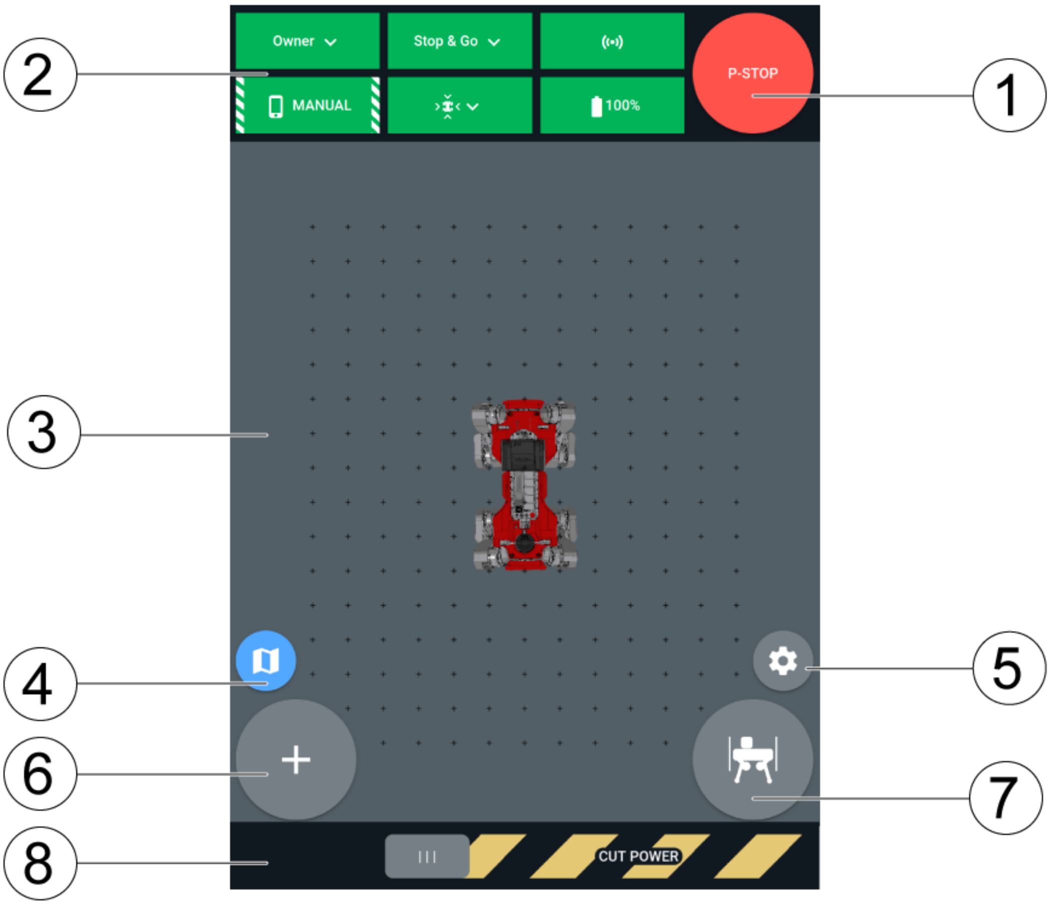
The task status gives you information on the current status or outcome of the task.

Table 14 - Task status indicators

	Task anomaly	Shows the task result is an anomaly. For example, if a measured value is outside the normal operating range.
	Task in progress	Shows the task is in progress.
	Task skipped	Shows the task was skipped by the Operator. For example, when the Operator chose to start the mission from a later task instead of the first task.
	Task successful	Shows the task was completed successfully. For example, a measured value could be read and was in the normal operating range.
	Task unsuccessful	Shows the task was unsuccessful. For example, a measured value could not be read.
	Task upcoming	Shows the task result is being processed.

3.3 ANYbotics Workforce app overview

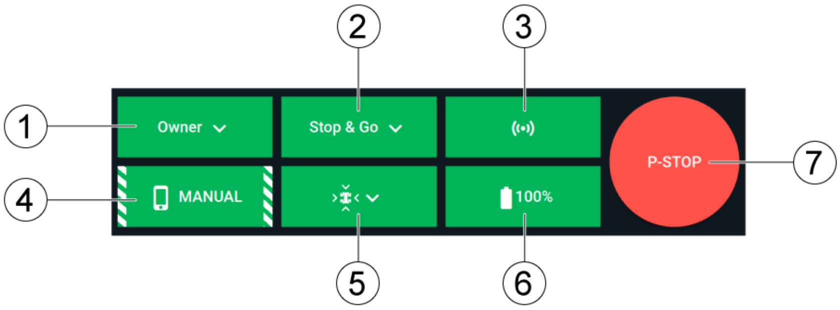
These are the main functions of the ANYbotics Workforce app.



1	Protective stop	Used to activate a protective stop. Always visible. ▶ *For more information, see "8.3.3 How to activate the protective stop using the ANYbotics Workforce app" on page 205*
2	Status bar	Shows the basic information and connectivity status of the ANYbotics Workforce app.
3	Robot view	Shows the Robot and its environment.
4	3D map	Shows the map of the environment.
5	Contextual menu	Gives access to additional options for every page.
6	Operator task menu	Gives access to all functions to implement the environment.
7	Robot control menu	Contains tools to control the motion of the Robot and the inspection payload. Shows the selected operational mode. ▶ *For more information, see "8.3.5 How to change operational modes using the ANYbotics Workforce app" on page 207*

8	Cut power slider	Used to cut the power from the drives of the Robot. Always visible. ▶ *For more information, see "8.3.4 How to activate the cut power using the ANYbotics Workforce app" on page 205*

Figure 30 - Overview of the ANYbotics Workforce app



1	Control authority	Used to take and release control of the Robot. Always visible. ▶ *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*
2	Collision avoidance setting	Shows the collision avoidance setting. ▶ *For more information, see "8.3.11 How to change collision avoidance behavior using the ANYbotics Workforce app" on page 222*
3	Connectivity status	Shows if the ANYbotics Workforce app is connected to the Robot.
4	User interaction mode	Shows the current user interaction mode of controlling of the Robot.
5	Localization status	Shows the localization status of the Robot. ▶ *For more information, see "8.3.13 How to localize the Robot" on page 224*
6	Battery level and pressure level	Shows the battery level and pressure level values.
7	Protective stop	Used to activate a protective stop. Always visible. ▶ *For more information, see "8.3.3 How to activate the protective stop using the ANYbotics Workforce app" on page 205*

Figure 31 - Overview of the status bar

3.3.1 The operator task menu

You can access the operator task menu from the ANYbotics Workforce app main page.

The operator task menu displays options used to configure the robot's environment.

To open the operator task menu, select  on any page.

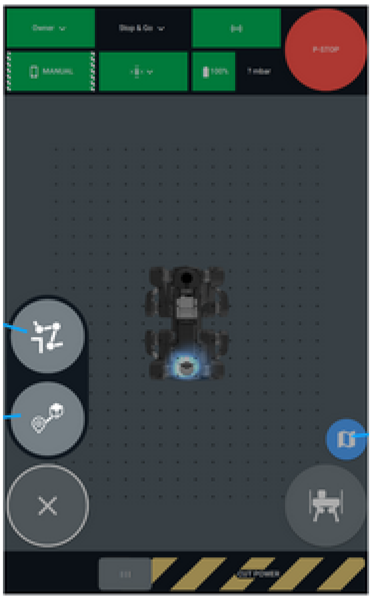


Figure 32 - The operator task menu

The operator task menu gives you the following options:

	Open the recording page.
	Open the operator task page.

3.3.2 The 3D map display

Using the 3D map, you can view the robot's location and its operation environment.

To display the 3D map, select .

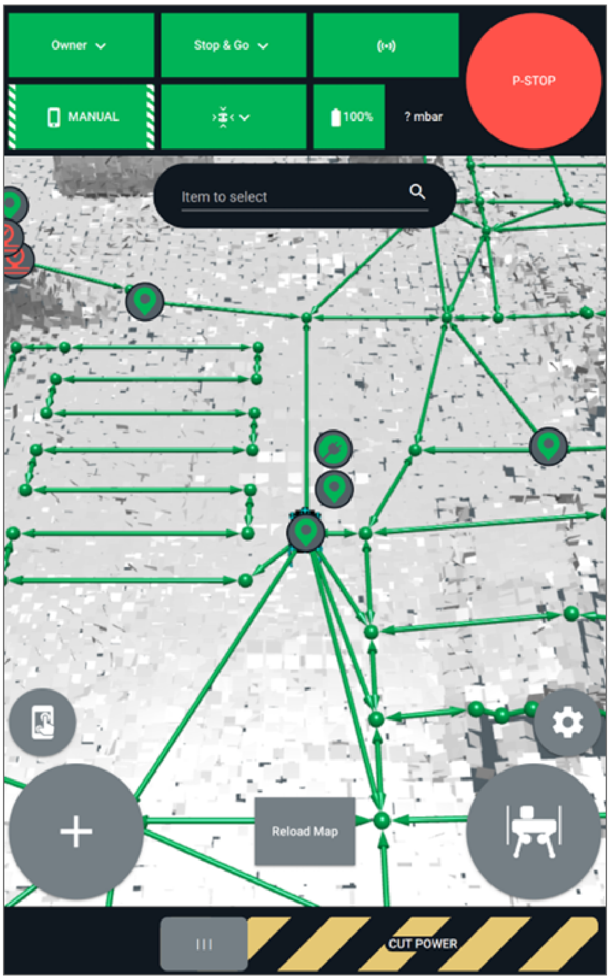
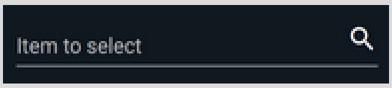
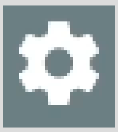


Figure 33 - 3D map

	Search for a point of interest or navigation goal. When you have selected the item, the details are displayed in the editing pane.
	Change the user input from multi-touch to single-touch. See 3.3.2.1 "*Change the user input from multi-touch to single-touch*".
	Open 3D map options. See Table 15 - "*3D map options*".

	Open the operator task menu. ▶ *For more information, see "3.3.1 The operator task menu" on page 94.*
	Open the Robot control menu. Contains tools to control the motion of the Robot and the inspection payload. Shows the selected operational mode. ▶ *For more information, see "8.3.5 How to change operational modes using the ANYbotics Workforce app" on page 207*

Table 15 - 3D map options

	Lock or unlock the camera on a selected object
	Display or hide live LIDAR measurements
	Display or hide waypoints
	Display or hide environment objects ▶ *For more information, see "3.2.7.2 Environment objects" on page 86*
	Display or hide the map visualization

3.3.2.1 Change the user input from multi-touch to single-touch

You may want to manipulate items on the screen when you have only a single point of input, for example if you are using a stylus. If you select single-touch input, you can control the camera movement with simple drag on the screen.

1. Select .
2. Select from one of the following camera movements:
   - Rotation: 
   - Zoom: 
   - Lateral movement: 

You can now move the camera with a single movement on the screen.

- To return to multi-touch input, select .

3.3.2.2 Edit items from the 3D map display

In the 3D map display, using manual mode, you can select and edit all point of interest objects and navigation goals.

To edit an item, follow these steps:

1. Select an item by pressing the item on the screen, or searching for the item name using the search bar.

   The selected item is displayed with a white outline.
2. From the overview page (see Figure 34), select **Edit**.
3. From the edition page (see Figure 35), you can do the following:
   - Change the type of the item.
   - Set the pose for the Robot.
   - Set the tolerance.

4. To finish editing, select **Update**.

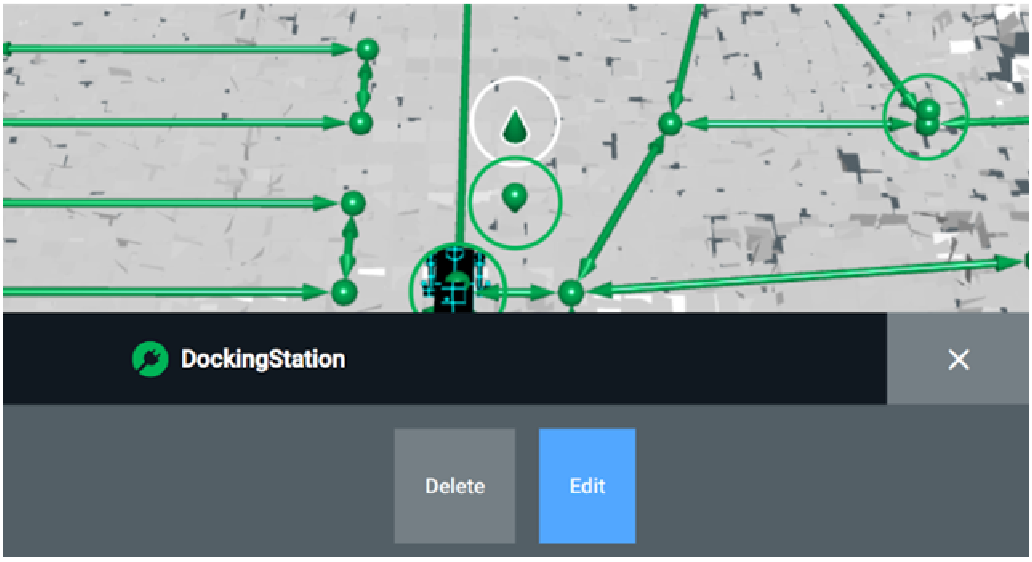


Figure 34 - Overview page

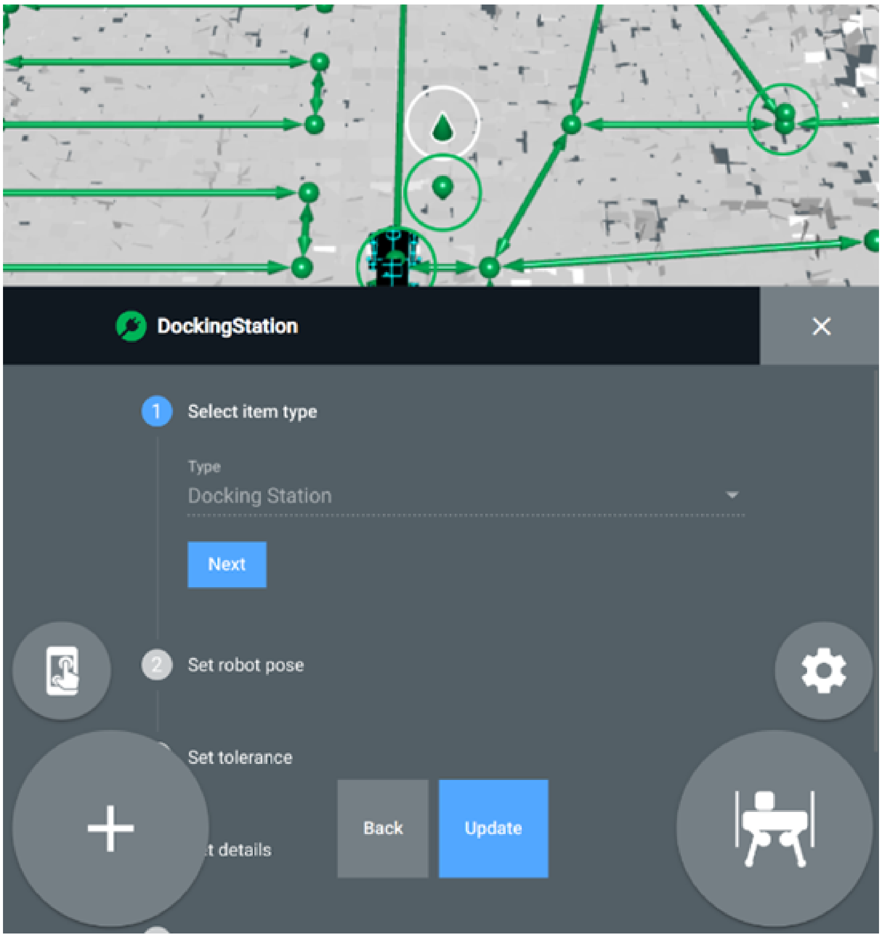


Figure 35 - Edition page

3.4 Data synchronization server

A data synchronization server is necessary to transfer data to and from the Robot computers. For example, the data synchronization server is used to update environment data packages, archive and download mission reports, and access log files from the Robot.

A data synchronization server is accessed either by an on-Robot agent or a client installed on the operator computer:

- **On-**Robot **agent**: On-Robot agents establish and secure a connection to one or more data synchronization servers. An efficient event-based system allows the agent to notify servers of any changes to files on the Robot.
- Operator computer **client**: Clients connect to a data synchronization server, download automatically transferred files and request file transfers from on-Robot agents.

A data synchronization server can be one of three types:

- **Global infrastructure server**: A server operated by ANYbotics as a service for any Robot owner. When an on-board agent connects to the global infrastructure server, the server automatically synchronizes all onboard files. The server can be reached at `data-sync.anybotics.com:58050`.

> **Notice**
> Use of the global infrastructure server is an optional service for ANYbotics customers. The Robot will not connect to the global infrastructure server by default.
>
> For more information, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

- **Local infrastructure server**: A server operated by the Robot owner. A local infrastructure server can be operated in a similar way to a global infrastructure server.
- **Local ad-hoc server**: An ad-hoc server operated by the Robot owner, usually on the Operator computer. The ad-hoc server is for temporary use and allows for unauthenticated access.
  - ▶ *For more information, see "5.2 Install the ad-hoc data sync server" on page 115*

Data stored on a data synchronization server can only be accessed by authenticated and authorized users. Authentication is done with one of two options:

- **TLS Client Certificate**: Usually, on-Robot agents present a data synchronization server with a pre-installed TLS Client Certificate which authenticates the agent via the ANYbotics root certificate. This system uses TLS/SSL encryption to guarantee "encryption in transit" and prevent "man-in-the-middle" attacks.

  With this scheme in place, agents can connect to any data synchronization server without additional configuration.
- **User management**: Users of the operator GUI authenticate their client with a username and password. This ensures that no unauthenticated user can access data on the data synchronization server.

To discuss specific authentication requirements, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

3.5 VPN server

By default, the Robot is configure for operation using either the ANYbotics Workforce app or an OPC configured to be in the same local network as the Robot. The OPC cannot communicate with the Robot directly from an external network. However, communication between the Robot and an OPC in an external network can be established by using a Virtual Private Network (VPN). To make this work, a computer accessible (for example, it can be pinged) from both the Robot and the OPC must be available for use as a VPN server. All traffic between the OPC and the Robot will be re-routed through the VPN server. Other traffic, for example, communication between the PCs on the Robot or software updates, will not be affected and will still go through the normal network interface.

▶ *For more information, see "7.2.1 Configure the VPN server" on page 189*

3.6 Programming

The functionality of the Robot can be extended by directly programming the onboard software. Best practices and tips for programming the onboard software are detailed in the ANYmal Software Development Guide.

The application interfaces are described in the ANYmal Application Programming Interface Guide.

► *For usage and configuration information, refer to the ANYmal Software Guide.*

3.7 Simulation

The ANYmal simulation is a tool to test the Robot in a virtual environment. It offers a quick and safe way to test or practice using Robot features, for example:

- Editing environment data
- Running missions
- Controlling and monitoring the Robot via API
- Testing configuration changes

The simulation is a close representation of its real-world equivalent. It models most of the Robot's sensing and actuation capabilities in an accurate way.

The software stack which runs in simulation is very close to the software stack on the Robot, with the exception of low-level software like drivers and firmware.

► *For more information, see "5.8 Install the simulation" on page 120*

► *For more information, see "5.9 Start the simulation on your computer" on page 120*

4 INSTALLATION AND COMMISSIONING

The ANYbotics systems and Robot must be installed correctly and by trained personnel.

> **Warning**
>
> Risk of serious injury or death resulting from incorrect installation and commissioning!
>
> Errors in the installation or commissioning can result in life-threatening situations and cause significant property damage.
>
> Read this section to ensure the correct installation and configure of the Robot.

4.1 Unpack the Robot

The Robot is delivered to you in a Transport Box or transport pallet.

Unpack the Robot in a clean and dry room. Check that all items are present. If there are any items missing or damaged, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

Four people are needed to lift the Robot out of the Transport Box.

Use the handles provided, when lifting the Robot.

- ► *For more information, see "1.14 Lifting the Robot" on page 44*
- ► *For more information, see "2.3.3 Handles" on page 55*

4.1.1 What is in the Transport Box

The Transport Box contains the following items:

- One Robot
- One Robot battery
- One Robot battery charger, with charging cable and power cable
- One Robot battery charging adapter
- One ethernet cable (M12-RJ45-Interface cable)
- Four handles used for lifting the Robot

The following items can be in the Transport Box if you acquired the corresponding accessories:

- One docking station
- One spare Robot battery
- One inspection payload (attached to the Robot)
- One cellular module 4G/LTE

4.2 Insert the Robot battery

Warning

Risk of injury or damage to equipment!

Do not operate the Robot without the bottom shell fitted. The bottom shell protects the battery from damage.

Tools required:

- 4 mm Allen key
- Loctite™ 222

To insert the battery into the Robot follow these steps:

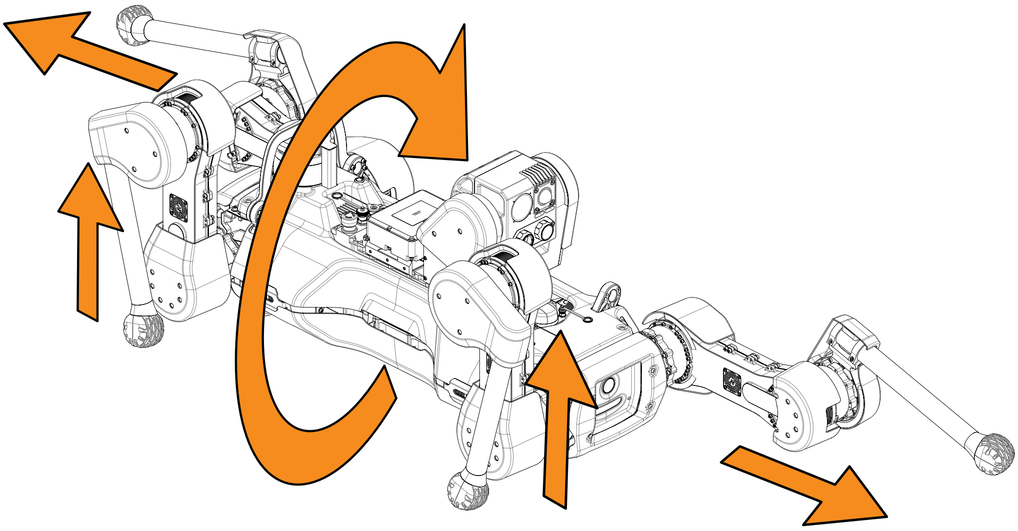


Figure 36 - Position legs for roll over of the Robot

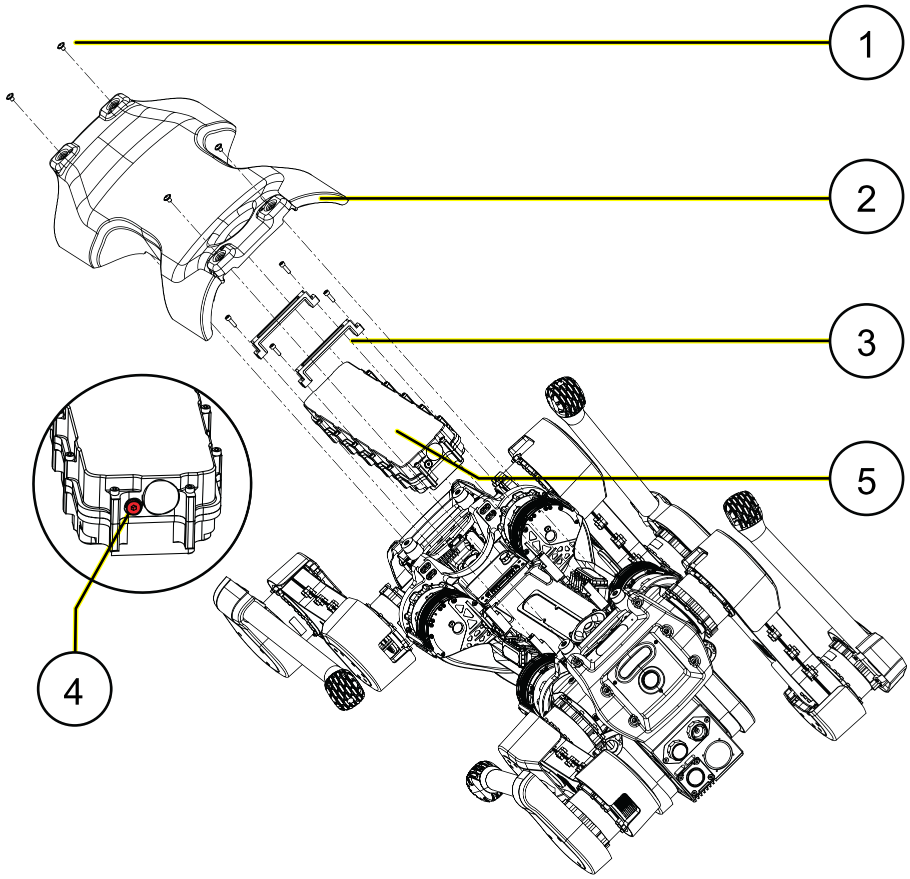


Figure 37 - Underside of Robot showing bottom shell and battery assembly

1. Extend the legs on one side of the Robot and push up the opposite legs.
   See the orientation of the Robot in Figure 36.
2. Roll the Robot, on the extended legs, onto its back to expose the bottom shell.
3. Remove the four M6 screws (item 1) attaching the bottom shell (item 2) to the Robot body (see Figure 37).
4. Remove the bottom shell (item 2) from the Robot.
5. Remove the four M5 screws attaching the two battery brackets (item 3) to the Robot body.
6. Remove the two battery brackets (item 3).
7. Tighten the M8 valve plug on the end of the Robot battery to 2 Nm (item 4).
8. Insert the battery (item 5) so that the pins of the battery contact the socket on the Robot body.
9. Attach the battery using the two battery brackets (item 3) and the four M5 screws.
10. Tighten the M5 battery bracket screws to 0.5 Nm.

Notice

Do not apply Loctite™ to the battery bracket screws.

Do not tighten the battery bracket screws too much. This can damage the battery.

11. If required, apply Loctite™ 222 to the four M6 screws and attach the bottom shell (item 2) to the Robot body.

Notice

If the battery is removed from the Robot each day for overnight storage, Loctite™ 222 does not need to be applied to the four M6 bottom shell screws. The screws must be tightened to 0.5 Nm every time the bottom shell is attached.

If the battery is left in the Robot, Loctite™ 222 must be applied to the four M6 bottom shell screws.

12. Tighten the four M6 screws to 0.5 Nm.

4.3 Turn on the system

To start the Robot:

1. Ensure the Robot legs and feet are in the position shown.

   When starting the Robot, the feet must touch the ground.

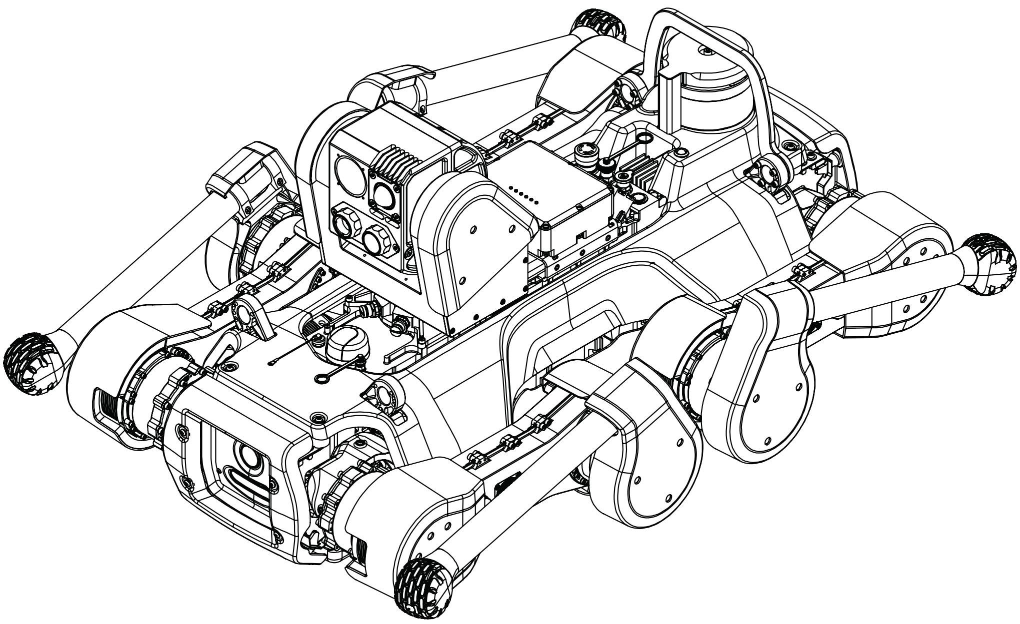


Figure 38 - Robot starting position

2. Release the Robot emergency stop.
3. Press the Robot power button.

► *For more information, see "8.2.3 How to manage control of the Robot using the GUI" on page 202*

► *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*

4.4 Commission the system

When using the Robot, all safety functions must be working.

4.4.1 Test safety functions

The following safety functions must be tested before the first use of the Robot. During normal use, regularly test the safety functions as described in the Service and Maintenance section.

- Robot emergency stop
- ANYbotics Workforce app cut power
- Delayed start with warning
- Danger zone active warning light

▶ *For more information, see "10.2.1 Safety functions" on page 277*

4.5 Shut down the system

Warning

Risk of serious injury or death!

Do not use the Robot emergency stop to shut down the Robot. A regular, sudden loss of power may damage Robot systems.

Do not approach the Robot if the danger zone active warning light is on.

To shut down the Robot, follow these steps:

1. Change the Robot operational mode to .
   ▶ *For more information, see "8.3.5 How to change operational modes using the ANYbotics Workforce app" on page 207*
2. Ensure that the danger zone active warning light is off.
3. Press and hold the Robot power button.
   The status light will start pulsing white.
4. When the status light starts slowly blinking red, release the power button.

Notice

There is a 30 second delay before the Robot is fully shut down.

4.6 Install the battery charger and docking station

The battery charger and docking station must be correctly installed to ensure the Robot batteries can be safely charged.

4.6.1 Install the battery charger

The battery charger must be correctly installed to ensure Robot batteries can be charged safely.

To install the battery charger, follow these steps:

1. Select a suitable location for the battery charger.
   - It is recommended that the battery charger is installed in a dry, indoor environment.
   - The battery charger must be installed in an environment with an ambient temperature between 0 °C and 35 °C.
   - There must be no flammable objects within a 2 m radius of the battery charger.
2. Using the hole pattern on the back of the battery charger, mount the battery charger to a wall.

Notice

Unlike the Robot, and other accessories, the battery charger is not ingress protected according to IP67.

Some degree of water ingress protection can be achieved by mounting the battery charger vertically, with the AC socket pointing down. For exposed installations, a cover over the battery charger is recommended.

All other forms of installation do not provide any type of water ingress protection. Therefore, all other forms of installation must only be used in dry environments

4.6.2 Install the docking station

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The docking station allows the Robot to be charged autonomously.

- The docking station should be installed in a safe location that is protected from weather damage.
- The docking station should not be installed in a place where it might interfere with safe access routes.
- The docking station should be installed in a location where there is adequate light for the Robot to detect the AprilTags on the docking station.
- The docking station should be installed in a well-lit location.
- The docking station should be installed in a location with a uniform bright background color.
- The docking station should not be installed in a location with other stripes or similar patterns in the surroundings.

The docking station should be installed in a safe and easy to access location. Figure 39 and Figure 40 show the recommended installation details and locations.

- Docking area
- Detection area

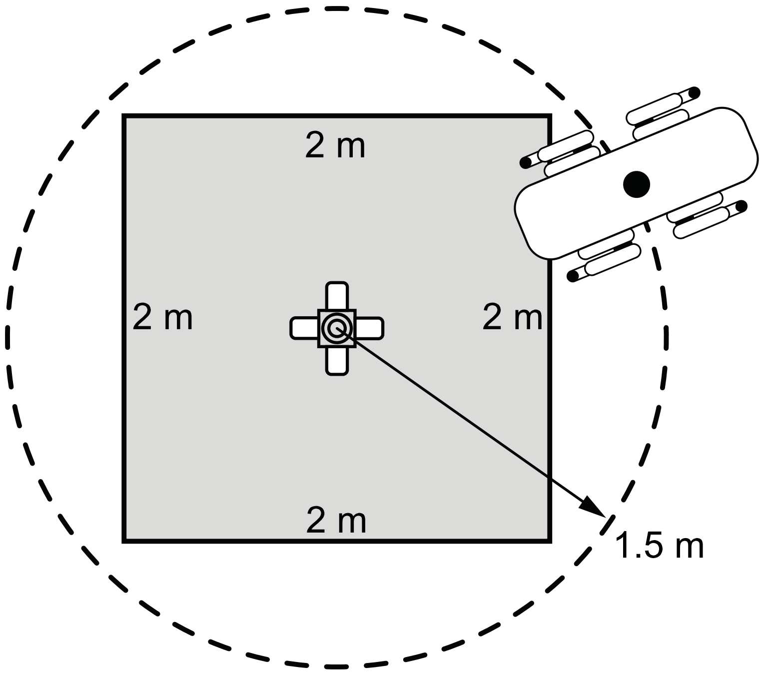


Figure 39 - Docking station in an open area

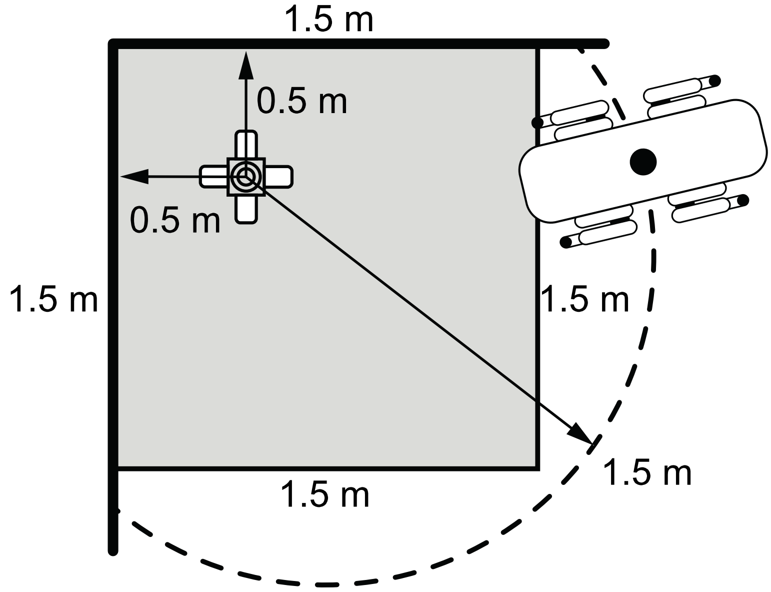


Figure 40 - Docking station in a corner

To install the docking station, follow these steps:

1. Place the docking station on the floor.
2. Bolt the docking station to the floor using the holes in the base of the docking station around the connector cone.
   ► *For more information, see "12.10 Docking station" on page 309*
3. Connect the charging cable from the battery charger to the docking station.

Caution

Risk of injury!

Ensure the charging cable is positioned so that it does not cause a trip hazard.

▶ *For more information, see "2.3.18 Battery charger and adapter" on page 68*

5 GETTING STARTED

> **Notice**
>
> All safety information and procedures must be read and understood to ensure the Robot can be operated safely.
>
> The default router password and all Robot computers (LPC, NPC) default passwords must be changed the first time they are used.

This section covers typical getting started procedures that must be performed before using the Robot.

5.1 Installation prerequisites

The following is required to install the operator graphical user interface (GUI):

- A computer with the Linux Ubuntu 20.04 operating system that meets the minimum system requirements.
- A user with `sudo` rights
- An internet connection

The following must be done before starting the operator GUI installation:

- Install Linux software tools.
- Add the Robot operating system (ROS) Debian Repository.
- Add the ANYmal Software Debian Repository.

5.1.1 System requirements

The following operator computer system requirements are recommended to run the operator graphical user interface (GUI) effectively.

Table 16 - Minimum and recommended operator computer system requirements

Description	Minimum	Recommended
Example Operator computer	Lenovo ThinkPad T480	Lenovo ThinkPad T14
Processor	Intel® Core™ i5-8350U	Intel® Core™ i7-1165G
Onboard memory	16 GB RAM	16 GB RAM
Graphic card	Nvidia MX150	NVIDIA® GeForce® MX450

For more information about operator computer system requirements, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

5.1.2 Install Linux software tools

To install the operator graphical user interface (GUI), some common Linux software tools must be installed.

> **Notice**
>
> On a new Linux Ubuntu 20.04 installation these software tools are not installed by default.

To install the Linux software tools:

1. Open a terminal session.
2. Run the following command.

```
sudo apt install lsb-release gnupg2 ca-certificates curl
```

3. Enter `y` and press `Enter` to confirm installation, if needed.

5.1.3 Add the ROS Debian Repository

To add the ROS Debian Repository:

1. Open a terminal session.
2. Run the following command.

> **Tip**
>
> Replace `<xx.yy>` with the current software release number.

```
sudo sh -c 'echo "deb [arch=amd64] https://packages-ros.anybotics.com/ros/release-<xx.yy>/ubuntu $(lsb_release -sc) main" > /etc/apt/sources.list.d/any-ros.list'
curl -fsSL https://packages.anybotics.com/gpg | sudo apt-key add -
sudo apt update
```

3. To confirm the installation suggestions, enter `y` and press `Enter`.

5.1.4 Add the ANYmal Software Debian Repository

To add the ANYmal Software Debian Repository:

1. Open a terminal session.
2. Run the following command to add the PPA login credentials to the system.

> **Tip**
>
> Replace `<user>` and `<password>` with your username and password.

```
sudo sh -c 'echo "machine packages.anybotics.com login <user>
password <password>" >
/etc/apt/auth.conf.d/packages.anybotics.com.conf' && sudo chmod 600
/etc/apt/auth.conf.d/packages.anybotics.com.conf
```

3. Add the preferred release version to the software sources.

> **Tip**
>
> Replace `<xx.yy>` with the desired or selected software release number.
>
> Replace `<customer_type>` with:
>
> - `anymal` if you are a regular customer.
> - `anymal-research-software` if you are a research customer.
> - Your organization name if a special PPA was created for you.

```
sudo sh -c 'echo "deb [arch=amd64]
https://packages.anybotics.com/<customer_type>/release-
<xx.yy>/ubuntu $(lsb_release -sc) main" >
/etc/apt/sources.list.d/anymal.list'
```

4. Add the Robot-configuration Debian repository.

```
sudo sh -c 'echo "deb [arch=amd64]
https://packages.anybotics.com/robot-configuration/ubuntu/ $(lsb_
release -sc) main" > /etc/apt/sources.list.d/anymal-config.list'
```

5. Finish the configuration by adding the required gpg key and tell `apt` to prefer packages coming from packages.anybotics.com.

   This ensures that customised system dependencies (for example, `libpcl`) stay at a version compatible with the ANYmal software stack.

```
curl -fsSL https://packages.anybotics.com/gpg | sudo apt-key add -
sudo sh -c 'echo "Package: *\nPin: origin
\"packages.anybotics.com\"\nPin-Priority: 990" >
/etc/apt/preferences.d/anybotics-default'
sudo apt update
```

5.1.5 Install your software license on the operator computer

To access the software options which you purchased, you need to install your organization-specific software license on your computer.

To install your software license, follow these steps:

1. Download the software license to the operator computer (OPC).
2. To create the ***/etc/robot/*** directory, enter the following command:

```
sudo mkdir /etc/robot
```

> Tip
> If the ***/etc/robot/*** directory exists, this command returns the following message:
> `mkdir: cannot create directory 'test': File exists`
> If this message is displayed, proceed to step 3.

3. To install the entitlement file, enter the following commands on the OPC:

```
cd Downloads
sudo mv entitlements.yaml /etc/robot/entitlements.yaml
```

5.2 Install the ad-hoc data sync server

You can activate an ad-hoc data synchronization server by using the `ads_local` tool. Your Robot will automatically connect to this server, as long as the Robot is in the same network.

You must perform the installation on the operator computer.

> Notice
> The ad-hoc server provides convenient access to Robot data. This means that the data can be accessed by unauthorized users.
> ▶ *For more information, see "5.2.2 Configure the ad-hoc server" on page 116*

5.2.1 Preconditions for the ad-hoc server

Install the `ads_local` tool with the following command:

```
sudo apt install ads-local
sudo groupadd docker
sudo usermod -aG docker $USER
newgrp docker
```

> **Notice**
> If necessary, the script will prompt for your `sudo` password.

5.2.2 Configure the ad-hoc server

You need to install additional software to use the ad-hoc data sync server.

To install the software, run the following line:

```
ads_local install
```

You can choose a custom data directory using the following option:

Argument	Long form	Short form	Description
data-dir	`--data-dir <path>`	`-D <p>`	Directory where the container setup is configured. This directory will also contain all the data stored by the ad-hoc server. Default: `$HOME/.local/share/ads.local`

To change the data directory you need to run a forced installation using the following option:

Argument	Long form	Short form	Description
force	`--force`	`-f`	Force installation. Note that this also removes all previously generated and stored data from `data-dir`.

5.2.3 Update the ad-hoc server

You need to update the ad-hoc data sync server manually.

To update the ad-hoc server run the following line:

```
ads_local update
```

> **Notice**
> If necessary, the script will prompt for your `sudo` password.

Notice

You don't need to update the ad-hoc server after its installation, as the `ads_local install` command automatically runs `ads_local update`.

Notice

If you use a custom path for the installation, you need to use the same path for the update.

If you want to change the directory, you need to use the forced installation.

5.3 Install the operator graphical user interface (GUI)

To install the operator graphical user interface (GUI):

1. Open a terminal session.
2. Update the list of installable software packages.

```
sudo apt update
```

3. Install the configuration package for your Robot.

Tip

Replace `<anymal-name>` with the name of your Robot.

```
sudo apt install ros-noetic-anymal-config-<anymal-name>
```

This step must be repeated for multiple Robots.

4. Run the following command to install the operator GUI.

```
sudo apt install ros-noetic-anymal-d-opc
```

5. To confirm the installation suggestions, enter `y` and press `Enter`.

5.4 Start the Robot

To start the Robot:

1. Ensure the Robot legs and feet are in the position shown.

   When starting the Robot, the feet must touch the ground.

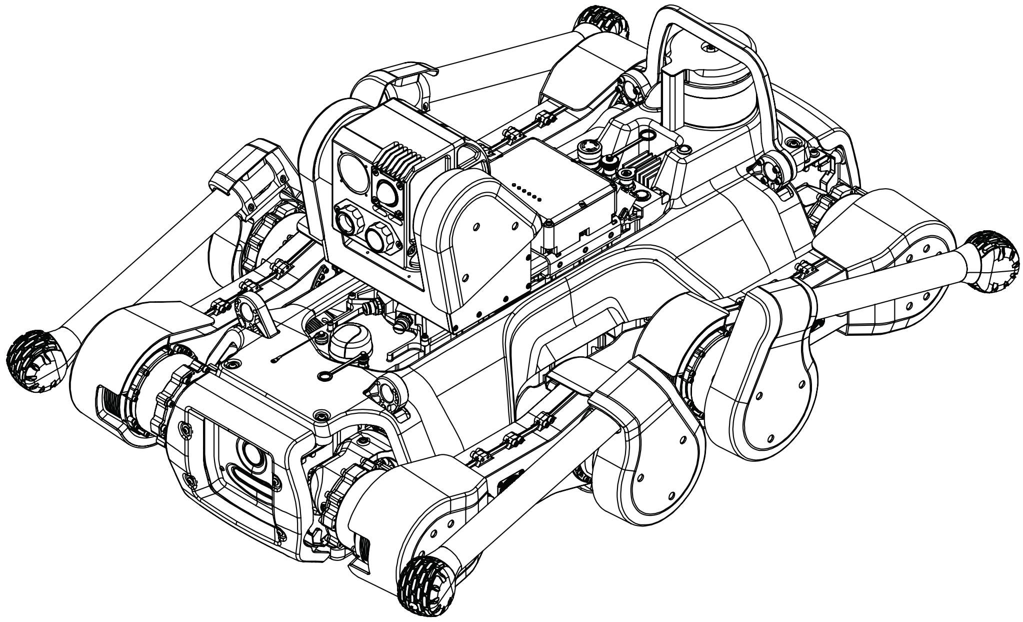


Figure 41 - Robot starting position

2. Release the Robot emergency stop.
3. Press the Robot power button.

► *For more information, see "8.2.3 How to manage control of the Robot using the GUI" on page 202*

► *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*

5.5 Connect the operator computer to the Robot network

The operator computer must be connected to the Robot network to launch the operator graphical user interface (GUI).

To connect the operator computer to the Robot network, set a static IP in the Robot network Wi-Fi settings by following these steps:

1. Open **Wi-Fi Settings** on the operator computer.
2. Select the Robot network `<anymal-name>-wifi` or `<anymal-name>-wifi-2.4`.

5.6 Start the operator graphical user interface (GUI) on your computer

Before starting the operator graphical user interface (GUI) on your computer, make sure that:

- You have installed the operating software on your computer.
- The Robot is powered and had sufficient time to boot and start all software modules.
- You are connected to the same Wi-Fi network as the Robot.

To start the operator GUI on your computer, follow these steps:

1. Start the **ANYmal software launcher** application on your computer.
2. Select **OPC**.
3. Refresh the list to find all Robots in the network.
4. From the dropdown menu, select your Robot.
   If your Robot is not listed, try entering the Robot name manually.
5. Select **Start**.
6. Enter your password.

► *For more information, see "3.2 Operator graphical user interface (GUI) overview" on page 76*

5.7 Change the Robot password and configure maintainer access

To protect the Robot from unauthorized access, you must change the password used to access the Robot's settings.

After you change the password, ANYbotics no longer has access to the Robot. To allow access for maintenance, you must create a maintainer access using SSH keys.

Warning

The SSH keys allow root access to the Robot. They should only be shared with ANYbotics, and only in the case of upcoming Robot maintenance.

Make sure to store the SSH keys securely. Contact your IT department for instructions.

Notice

When you send the robot to ANYbotics for maintenance, you must send the SSH keys allowing maintainer access as well. Make sure to use a secure channel, for example, store the SSH keys on a USB stick and send it separately to the Robot.

Tip

To change the password and generate SSH keys, you must be connected directly to the Robot. You cannot do this procedure over VPN.

To change the password and configure SSH keys for maintainer access, do the following:

1. Start the **ANYmal software launcher**.
2. Select your Robot.
   You may need to refresh the list to find all Robots in the network.
   If your Robot is not listed, enter the Robot name manually.
3. Select **Access settings**.

4. Enter the current Robot password.
   If you have never changed the password for this Robot, the current password is in the datasheet.
5. In **SSH key path**, either choose a folder which already contains the keys for this Robot or choose a folder where you want the SSH key to be generated.
6. Select **Register SSH keys**.
7. Enter the new password in the **New password** and **Repeat password** fields then select **Set**.

The password has now been changed and maintainer access configured.

5.8 Install the simulation

To install the simulation:

1. Open a terminal session.
2. Run the following command:

```
sudo apt install ros-noetic-anymal-d-sim
```

3. To confirm the installation suggestions, enter `y` and press `Enter`.

5.9 Start the simulation on your computer

Make sure you installed the simulation.

► *For more information, see "5.8 Install the simulation" on page 120*

To start the simulation on your computer, follow these steps:

1. Start the ANYmal software launcher application on your computer.
2. Select **Simulation**.
3. Select to find all installed Robot configurations on your computer.
4. From the **Robot** dropdown, select the desired configuration.
   D stands for the ANYmal (gen. D).

> **Notice**
> To configure the simulation, you can also select **Feature Toggles**.
> For example, you can select an environment by entering the name of the environment's folder in the **Environment data folder** feature toggle.

5. Select **Start**.
   You now control the Robot in the simulation.

Use the following to control the simulation:

- To pause and resume the simulation, in the 3D visualization select **Tools/Gazebo**, or press `Space` on your keyboard.
- To control the speed of the simulation, select **Menu/Simulation**.
- To stop the simulation, select **Stop** in the ANYmal software launcher.

6 CONFIGURE THE OPERATION ENVIRONMENT

The operation environment must be configured correctly for the safe and efficient operation of the Robot.

To configure the operation environment:

1. Create an empty environment data package on the Robot locomotion computer.
   - *For more information, see "6.1.1 Create an empty environment data package" on page 123*
2. Synchronize the newly created environment data package from the locomotion computer to the navigation computer.
   - *For more information, see "6.3 Synchronize environment data package files" on page 124*
3. Command the Robot to load the newly created environment data package.
   - *For more information, see "6.5 Load the environment data package" on page 129*
4. Record a map of the operation environment.
   - *For more information, see "6.7.1 Record a map in the Graphical User Interface (GUI)" on page 131*

- Optionally, transform the map using the operator GUI.
   - *For more information, see "6.7.4 Transform the map in the Graphic User Interface (GUI)" on page 134*

5. Record the waypoints using the operator GUI.
   - *For more information, see "6.8.1 Record waypoints in the Graphic User Interface (GUI)" on page 135*
6. Edit the waypoints using the operator GUI.
   - *For more information, see "6.8.3 Edit waypoints in the Graphical User Interface (GUI)" on page 138*
7. Define points of interest.
   - *For more information, see "6.9 Define points of interest" on page 140*
8. Create a mission using the mission editor.
   - *For more information, see "6.10.1 Create a mission" on page 159*

> **Tip**
>
> Ensure you synchronize the environment data package every time the procedure requires it.
>
> - *For more information, see "6.3 Synchronize environment data package files" on page 124*

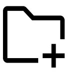
6.1 Create an environment data package

The environment data package stores information about the operation environment. The environment data package can be uploaded to, or downloaded from, the Robot.

Environment data packages are stored in ***~/ANYmal/Environments***.

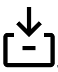
6.1.1 Create an empty environment data package

To create an empty environment data package, follow these steps:

1. From the **Data management** panel, select .
   The **Environment** window opens.
2. In the **Create Environment** box, enter the name of the new operation environment.
   For example, enter `new_data`.
3. Select  to create the environment folder structure.

6.2 Change the environment data package

To change the environment data package package using the operator GUI, follow these steps:

1. From the **Data management** panel, select .
   The **Environment** window opens.
2. From the **Load Environment** drop down list, select the environment data package you would like to change to.
3. Select .
   The current environment data package changes.

6.2.1 Change the default environment data package

> **Notice**
> It is not possible to change the default environment data package during a simulation.

To change the default environment data package package using the operator GUI, follow these steps:

1. From the **Data management** panel, select .
   The **Environment** window opens.
2. From the **Load Environment** drop down list, select the environment data package you would like to be the default.
3. Select .
   The default environment data package changes.

6.3 Synchronize environment data package files

When an environment data package is created or edited, the data must be synchronized between the operator computer and all Robot computers.

You need to start an ad-hoc data sync server before the first synchronization.

► *For more information, see "6.3.1 Start an ad-hoc data sync server" on page 124*

6.3.1 Start an ad-hoc data sync server

To start the ad-hoc data sync server, run the following command:

```
$ ads_local start
```

The ad-hoc data sync server starts and its address, `ads.local`, is published on the first connected external network interface that can be found.

The Robot automatically connects to the ad-hoc data sync server.

You can use the **GUI Data Sync** panel to interact with the Robots in your local network.

► *For more information, see "3.2.8.1 Data synchronization" on page 88*

You can also use the following arguments to configure the ad-hoc data sync server:

Argument	Long form	Short form	Description
interface	`--interface`	`-i`	Network interface adapter on which the domain name is to be published.
argument	`--address`	`-a`	IP address to be published. Specify either the `--interface` or the `--address`. Do not specify both.

6.3.2 Synchronize the environment data package on all computers

To synchronize an environment data package, follow these steps:

1. On the operator computer, open the operator graphical user interface (GUI).
2. Select the **Data Synchronization** panel.
3. In the **Connection** widget, enter the following information:

    a. Enter the address of the data synchronization server (for example, `ads.local`).

    ► *For more information, see "3.4 Data synchronization server" on page 99*

    b. Select an **Authentication method**.
    If using **Credentials**, enter your **Username** and **Password**.

    c. Select **Login**.

    d. Enter the **Robot name**

    e. Select **Connect**.

4. Select the **Data Package** tab.
5. In the **Local path** box, enter the environment data package parent folder.

    The file tree contains the merged environment data package structure of the operator computer files and the Robot computer files.

    - The first column shows the folder or file name.
    - The second column shows if the folder or file exists on the operator computer.
    - The other columns show the status of the folder or file on specific Robot computers.
    - The color shows the sync status between the Robot and the operator computer.
    - The tick, cross and question mark shows if the file exists on the Robot computer.

6. Select **Prune files from destination that are not synced (only if folder is selected)** if required.

    Select this option to remove files from Robot computers which are not present on the operator computer.

7. Under **Sync files from**, select **local**, **npc** or **lpc**.

    This option defines where files are being synced from.

8. Select **Sync**.

6.4 Configure a 3D mesh of the operation environment

You can add a 3D mesh to an operation environment if you want to:

- Help the user orient themselves in the 3D visualization of an operation environment. The mesh can show features, such as floors, walls, stairs or other points of interest. Setting up waypoints, inspection points and localizing the Robot is easier with the help of a 3D mesh.
- Simulate the Robot on anything different than a flat plane. The mesh can define the environment the Robot interacts with during a simulation.

6.4.1 Add a 3D mesh of the operation environment

To add a 3D mesh of the operation environment, follow these steps:

1. Create an empty environment data package.
   a. From the **Data management** panel, select .
      The **Environment** window opens.
   b. In the **Create Environment** box, enter the name of the new operation environment.
      For example, enter `new_data`.
   c. Select to create the environment folder structure.
   ▶ *For more information, see "6.4.2 Files and file structure of the 3D mesh" on page 127*
   d. Select to open the file browser.
2. Create a new model.
   a. Navigate to ***environments/<new_data>/models/***.
   b. Create a new folder called the name of the 3D model.
      For example, `new_model`.
   c. Navigate to ***environments/<new_data>/models/<new_model>/***.
3. Create new model files.
   d. Create a new folder called `meshes`.
   e. Create a new model configuration file called `model.config`.
   ▶ *For more information, see "6.4.3 File content" on page 127*
   f. Create a new model file called `model.sdf`.
   ▶ *For more information, see "6.4.3 File content" on page 127*
4. Create a new mesh.
   a. Navigate to ***environments/<new_data>/models/<new_model>/meshes/***.
   b. Create a new mesh file.
      For example, `new_mesh.dae`.
   ▶ *For more information, see "6.4.3 File content" on page 127*
5. Edit the world file.
   a. Navigate to ***environments/<new_data>/models/worlds/*** .
   b. Edit the ***world.world*** file.
   c. Add the following lines to the world file.

```
<include>
  <uri>model://new_model</uri>
</include>
```

   ▶ *For more information, see "6.4.3 File content" on page 127*
6. Start the new environment.
   a. From the **ANYmal software launcher**, select **Feature Toggles**.
   b. In the **Environment data folder**, enter the name of the new operation environment.
      For example. enter `new_data`.
   c. Select **Start**.

6.4.2 Files and file structure of the 3D mesh

The complete environment data package file structure, with a 3D mesh, should be as follows:

```
<new_data>
├── [...]
├── models
│   ├── docking_station
│   │   ├── meshes
│   │   │   ├── [...]
│   │   │   └── docking_port.dae
│   │   ├── model.config
│   │   └── model.sdf
│   └── <new_model>
│       ├── meshes
│       │   └── <new_mesh>.dae
│       ├── model.config
│       └── model.sdf
├── [...]
└── worlds
    └── world.world
```

Table 17 - Names and locations of the files

File	Description	Location
<new_ mesh>.dae	3D mesh file	***<new_data>/models/<new_mod- el>/meshes/***
model.sdf	Model file containing a link to the mesh	***<new_data>/models/<new_model>/***
model.config	Model configuration file	***<new_data>/models/<new_model>/***
world.world	World file containing a link to the 3D model	***<new_data>/worlds/***

6.4.3 File content

The files should have the following content.

model.config

```
<?xml version='1.0'?>
<model>
  <name>new_model</name>
  <version>1.0.0</version>
  <sdf version='1.5'>model.sdf</sdf>
  <author>
    <name>Author Name</name>
    <email>author@email</email>
```

```
  </author>
  <description>Model of the new mesh.</description>
</model>
```

model.sdf

```
<?xml version="1.0"?>
<sdf version="1.4">
  <model name="new_model">
    <pose>0 0 0 0 0 0</pose>
    <static>true</static>
    <link name="new_mesh_link">
      <visual name="new_mesh_visual">
        <pose>0 0 0 0 0 0</pose>
        <geometry>
          <mesh>
            <uri>model://new_model/meshes/new_mesh.dae</uri>
          </mesh>
        </geometry>
      </visual>
      <collision name="new_mesh_collision">
        <pose>0 0 0 0 0 0</pose>
        <geometry>
          <mesh>
            <uri>model://new_model/meshes/new_mesh.dae</uri>
          </mesh>
        </geometry>
      </collision>
    </link>
  </model>
</sdf>
```

world.world

```
<?xml version="1.0"?>
<sdf version="1.4">
  <world name="default">
    <include>
      <uri>model://sun</uri>
    </include>

    <include>
      <uri>model://new_model</uri>
    </include>

    <include>
      <uri>model://docking_station</uri>
      <pose>2.1 8.97 0.001 0 0 0</pose>
    </include>

    <plugin name="CustomWorldPlugin" filename="libworld_gazebo_
plugin.so"/>
  </world>
</sdf>
```

6.4.4 Export meshes from CAD software

You can export 3D meshes from other 3D modeling or CAD software, such as Blender or MeshLab.

To create and place the mesh in the environment data package, you must use one of these file formats:

- Collada (*.dae)
- Standard Triangle Language (*.stl)

> **Notice**
>
> The Collada file format supports colors and textures.
>
> The Standard Triangle Language format does not support colors and textures.

> **Notice**
>
> Collada files can have instanced duplications of objects, but these will be ignored by the simulation. The simulation only recognizes the original objects.

> **Notice**
>
> The files you export will be detailed and compressed. Converting such models can lead to large files which slows down the simulation.
>
> Using Collada meshes with a size of less than 100 MB will result in fast simulation rates.

> **Notice**
>
> The collision mesh can differ from the visualization mesh. A smaller collision mesh results in faster simulation rates.

6.5 Load the environment data package

To load an environment data package:

1. Take control of the Robot.
   - ▶ *For more information, see "8.2.3 How to manage control of the Robot using the GUI" on page 202*

2. From the **Data management** panel, select .
   The **Environment** window opens.

3. In the **Load Environment** box, from the dropdown menu, select the desired environment data package to load.
4. Select to load the selected environment data package.

- If you want the Robot to load this environment data package by default, select .

6.6 Import and export point clouds

SLAM and the SLAM Map Editor provide support for importing and exporting point clouds in the following formats:

- ***.e57***
- ***.ply***

Tip

Importing and exporting point clouds with SLAM requires an optional software package that you must purchase separately from SLAM.

- To export SLAM maps as point clouds, specify the extension of the exported file and then save it.

Notice

The ***.e57*** and ***.ply*** files are not direct replacements for SLAM map files. Whenever you export maps as point clouds, all information that cannot be represented as point clouds is lost. For example, you will lose the place recognition descriptors used for initializing localization.

To prevent this, make sure you save maps in the SLAM native ***.pb*** file format before exporting them as point clouds.

- To import point clouds and convert them to SLAM maps, you need to load them as regular map files.

Tip

We recommended that you downsample any point clouds you import using SLAM, so that they contain 1 point every 7.5 cm.

6.7 Create a map of the operation environment

A map of the Robot operation environment is created to allow the Robot to operate autonomously.

To build a map, sensors detect external cues such as building infrastructure to create a model of the world that the Robot can use to determine its position.

6.7.1 Record a map in the Graphical User Interface (GUI)

To record a new map, follow these steps:

1. From the operator graphical user interface (GUI), select the **Localization** status indicator to open the **Localization and Mapping** panel.
2. From the **Step 1: Workflow** tab, select **Build a new map**.
3. Walk around with the Robot to start mapping the work environment.
4. Monitor the mapping status in the **Robot status panel** of the GUI.
   The status indicator will display one of the following:
   - **Green**: Localization and Mapping is working well.
   - **Yellow**: there are too many disturbances from the environment or localization has not been initialized correctly.
   - **Red**: localization is lost.
   - **Black**: localization is disabled.
5. Monitor map generation:
   a. Select the **Operation** tab.
   b. Select **Visualize map**.
6. Select **Save** to save the map as a ***protobuf***(***.pb***) file.
7. Select **Done** to close the **Localization and Mapping** panel.

To extend an existing map, localize the Robot and select **Mapping** in the **Operation** tab.

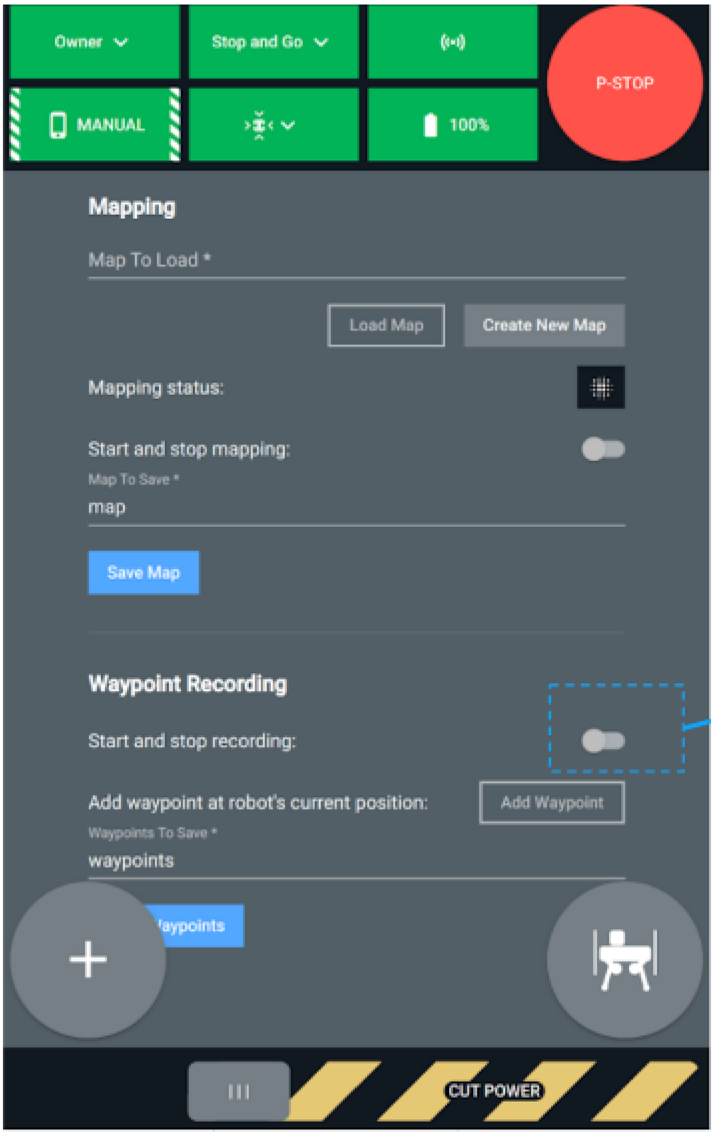
6.7.2 Record a new map using the ANYbotics Workforce app

You can configure the robot to automatically record the point cloud map while it walks around the site.

To update an existing map, see Section 6.7.3 "*Extend an existing map using the ANYbotics Workforce app*" on page 132

To record a new map, do the following:

1. Take control of the robot from the ANYbotics Workforce app.
   ▶ *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*
2. From the operator task menu (), select  to open the Recording page.



3. Select **Create New Map**.
   The **Mapping status** turns green and the **Start and stop mapping** toggle is enabled.
4. In the Robot control menu, open the Steering Control page.
5. Walk around with the Robot.
   The recorder maps the work environment.
6. When you are finished, return to the Recording page and select **Save Map**.
   The map is saved to the active environment data folder. By default, the map is saved as "`map`".

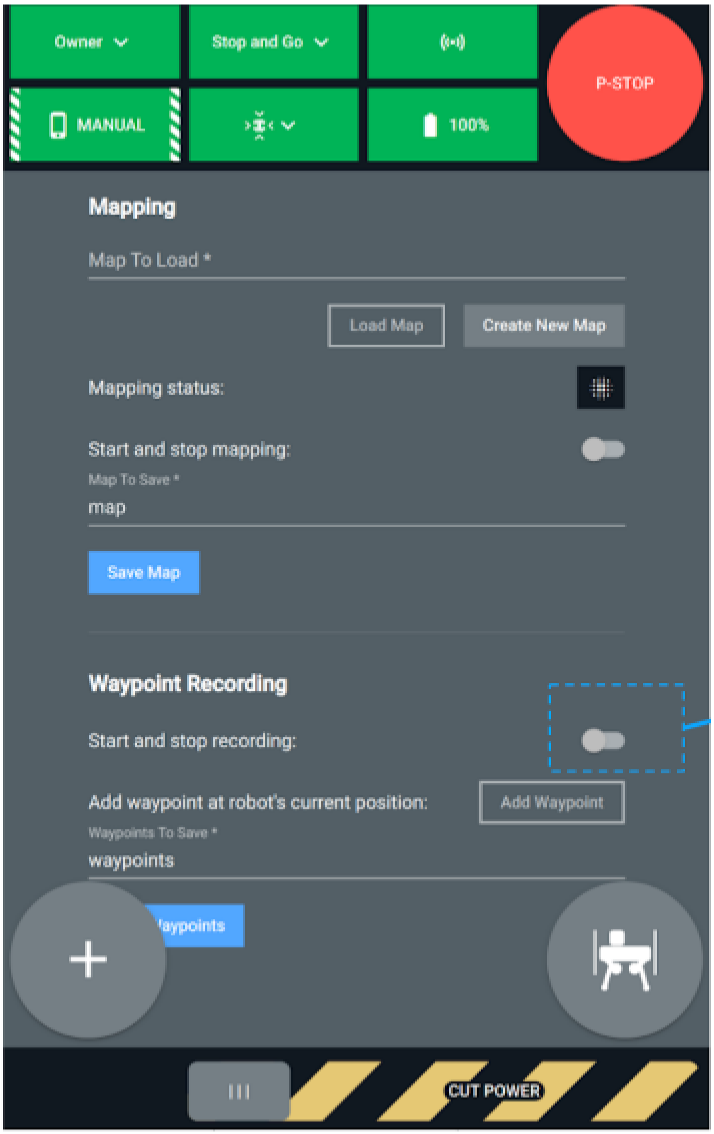
6.7.3 Extend an existing map using the ANYbotics Workforce app

You can configure the robot to automatically record the point cloud map while it walks around the site.

To record a new map, see Section 6.7.2 "*Record a new map using the ANYbotics Workforce app*" on page 131

To add information to an existing map, do the following:

1. Take control of the robot from the field app.
   ► *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*
2. From the operator task menu [], select to open the Recording page.



3. Select **Load Map** and load the map which you want to extend.
   The **Mapping status** turns green and the **Start and stop mapping** toggle is enabled.
4. In the Robot control menu, open the Steering Control page.
5. Walk around with the Robot.
   The recorder maps the work environment.
6. When you are finished, return to the Recording page and select **Save Map**.
   The map is updated and saved.

6.7.4 Transform the map in the Graphic User Interface (GUI)

After recording a map, it can be used for localization in the environment. The map coordinate system can be adjusted to meet specific requirements.

To reposition and reorient a map, use the **Localization and Mapping Maps Transformer** in the operator graphical user interface (GUI).

To transform a map, follow these steps:

1. From the operator GUI, use **Data Synchronization** to synchronize the map to the operator computer.
2. Select **Load** from the **Command** window.
3. Select a map file from the file browser.
4. Transform the map using one of the two following options:
    - Use section (A) of the **Command** window to guide you through an automated way of detecting planes that define an origin.
    - Use section (B) of the **Command** window to manually enter values to transform the origin.
5. Select **Save as** to save to a new file or select **Save** to overwrite the current file.
6. Use **Data Synchronization** to synchronize the map from the operator computer (OPC) to the Robot computers (LPC, NPC).
7. Make sure to reload the map before proceeding.

> **Notice**
>
> When transforming the map and resetting its origin, other data that relies on the absolute map position is not transformed. Therefore, it needs to be adapted separately.
>
> For example. a point of interest, the waypoints or the docking station position would not be transformed.

> **Notice**
>
> The Localization and Mapping Point Cloud Maps Editor only saves files in folders to which non-root users have access.
>
> For example, ***/home/<user>/*** instead of ***/opt/ros/<distribution>/<data_package>***.

6.8 Create waypoints

The Robot uses waypoints to autonomously navigate in a work environment. Waypoints include pose and path-following information, for example motion state and obstacle mode. The waypoints are recorded while operating the Robot.

You can create the waypoints by recording them first, and define them later using the **Waypoints Editor** in the operator graphical user interface (GUI).

6.8.1 Record waypoints in the Graphic User Interface (GUI)

The Robot can record waypoints while remotely operating. You can show the Robot the paths it can use. The Robot uses this information to autonomously navigate in the work environment. Recording waypoints is a simple and fast way to define waypoints.

> **Notice**
>
> Only once the Robot has built the map of the working environment, the Robot can localize itself. While recording waypoints, the Robot uses its localization information to add waypoints on the shown path. This means localization is a prerequisite for the **Waypoints Recording** feature to work.
>
> ▶ *For more information, see "6.7 Create a map of the operation environment" on page 130*

> **Caution**
>
> The **Waypoints Recording** is a beta feature to help you define the waypoints for the Robot. Always check the validity of the recorded waypoints with the **Waypoints Editor** before moving the Robot autonomously using the recorded waypoints.

The Robot will record a new waypoint in the following situations:

- The Robot motion state has changed.
- The Robot collision avoidance behavior has changed.

Each new waypoint is connected to the previously recorded waypoint.

To record waypoints, follow these steps:

1. From the GUI menu, select ☰.
2. Select **Waypoints Recording**.
   The **Waypoints Recording** window opens.
3. To start recording waypoints, select **Start Recording**.
4. Using the operator computer or the ANYbotics Workforce app, walk the Robot through the work environment.
   - You can also manually record a waypoint at the Robot's current location by selecting **Add Waypoint Here**.
5. To stop recording waypoints, select **Stop Recording**.
6. To save the recorded waypoints, select **Save**.

Notice

After saving the recorded waypoints, they are automatically loaded for planning paths or navigating the Robot autonomously.

Saving the recorded waypoints unloads previously loaded waypoints.

Tip

After you record the waypoints, you can now edit them.

- ► *For more information, see "6.8.3 Edit waypoints in the Graphical User Interface (GUI)" on page 138*

Tip

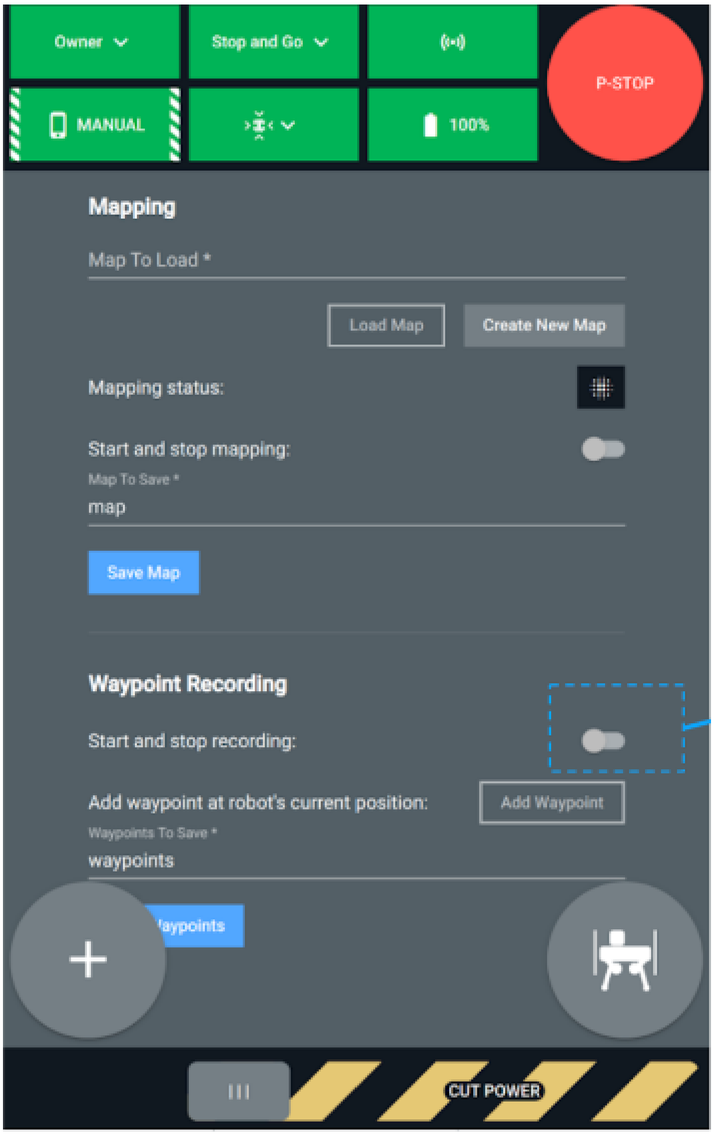
To load previously recorded waypoints, provide the absolute path to the waypoints file on the NPC and select **Open**.

6.8.2 Record waypoints using the ANYbotics Workforce app

You can configure the robot to record waypoints automatically while it walks around the site.

► *For more information, see "6.8 Create waypoints" on page 134*

1. Take control of the robot from the ANYbotics Workforce app.
   - ► *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*
2. Ensure the robot is localized.
   - ► *For more information, see "8.3.13 How to localize the Robot" on page 224*
3. From the operator task menu ( ), select to open the Recording page.



4. To start recording, slide the **Start and stop recording** toggle to the right.
5. In the Robot control menu, open the Steering Control page.
6. Walk around with the Robot.
   The recorder records waypoints.
7. To manually add a waypoint at the robot's current position, return to the Recording page and select **Add Waypoint**.
8. When you are finished, return to the Recording page and slide the **Start and stop recording** toggle to the left. This stops recording.
9. Select **Save Waypoints**.
   The waypoints are saved as a .json file on the robot NPC.
   To modify or use the recorded waypoints, use the Waypoints Editor in the Operator GUI.
   - ▶ *For more information, see* *"6.8.3 Edit waypoints in the Graphical User Interface (GUI)" on page 138*

6.8.3 Edit waypoints in the Graphical User Interface (GUI)

To navigate autonomously through a work environment, the Robot follows predefined paths defined by a set of nodes connected by edges.

> **Tip**
>
> It is recommend to record your waypoints first and then edit them.
>
> ▶ *For more information, see "6.8.1 Record waypoints in the Graphic User Interface (GUI)" on page 135*

The **Waypoints Editor** is used to create or modify waypoints. Nodes and edges are defined in a ***.json*** file in the data package ***environment_data/waypoints/*** folder.

> **Tip**
>
> When adding or modifying waypoints in the operator GUI, use **Data Synchronization** to synchronize the waypoints.
>
> - Before adding or modifying waypoints, synchronize the waypoints from the Robot computers (LPC, NPC to the operator computer (OPC).
> - After adding or modifying waypoints, synchronize the waypoints from the operator computer back to the Robot computers.

6.8.3.1 Add new nodes and edges

To add a new node:

1. Select ***Tools > Waypoints***.
2. Select anywhere in the **3D Visualization** panel, where the work environment is displayed.
3. To move a node, select ***Tools > Interact***, then select a node and move it by dragging it to a desired position.

   The position and orientation of the node can be precisely adjusted using the **X**,**Y** and **Z** coordinates in the **Waypoints Editor**. To use default tolerances, select **Ignore?**.
4. Select **Save**.

To add a new edge:

1. Select ***Tools > Waypoints***.
2. Choose the edge direction:
   - To create double-sided edges, select .
   - To create single-sided edges, select .
3. Select a node in the **3D Visualization** panel and hold while moving the mouse.
4. Release the mouse over another node. An edge will be created between the two nodes.

If the mouse is released between nodes, a new node will be created where the mouse was released. An edge will be created between the two nodes.

5. Use the **Waypoints Editor**, configure the following:
   - To determine the motion state of the edge, from the **Motion State** drop-down, select one of the options. If you're not sure, leave the **default** option.
   - To edit the motion parameters, next to the **Motion Parameters** box, Edit **Edit**. If you're not sure, leave the **default** option.
   - To determine the path follower, from the **Path Follower** drop-down, select one of the options. If you're not sure, leave the **default** option.
   - To determine the path follower, from the **Path Follower Mode** drop-down, select one of the options. If you're not sure, leave the **default** option.
   - To determine the path follower, next to the **Path Follower Parameters** box, Edit **Edit**. If you're not sure, leave the **default** option.
   - To determine the perception preset, from the **NFM Preset** drop-down, select one of the options. If you're not sure, leave the **default** option.

   > Notice
   >
   > If the **default** option does not work, change the value to **grated_surfaces_l0**.
   >
   > If the **grated_surfaces_l0** option does not work, change the value to **grated_surfaces_l1**.

   > Warning
   >
   > The grated surface values reduce the detection of cliffs making the map less detailed and less responsive to dynamic change.

   > Notice
   >
   > If you selected **stair_climbing** from the **Motion State** drop-down, from the **NFM Preset** drop-down, select **autodeduce**.

   - To determine the percentage of traversability, next to the **Traversability** box, enter the percentage value. If you're not sure, leave the `100%` value.
6. Select **Save**.

The newly created waypoint network can be used by closing the **Waypoints Editor** and selecting ***Tools > Interact***.

6.8.3.2 Change the direction of an edge

An edge uses one of the following directions:

- **Single edge (forward direction)**: the Robot can travel along the edge from the start node to the end node only.
- **Single edge (backward direction)**: the Robot can travel along the edge from the end node to the start node only.
- **Double edge**: the Robot can travel along the edge in either direction.

To change an edge direction, do the following:

1. Select ***Tools > Waypoints***.
2. Select the edge you want to change.
3. Select .
4. From the drop-down, select the edge direction you want to apply.
5. Select **Save**.

Tip

The new edge has the same properties as the old one.

Tip

If you select then select a double-sided edge, both directions of the edge are selected.

If you select then select a double-sided edge, only one of the two directions are selected.

Tip

You can select and modify more than one node or edge at the same time.

- Hold the keyboard **shift** key and select multiple nodes and edges.
- Select **all nodes** to select all nodes and **all edges** to select all edges.

You can only select multiple nodes and edges if the **Waypoints Editor** is active.

6.9 Define points of interest

A point of interest can be one of the following:

- **Docking station**: defines the location of the docking station.
- **Navigation goal**: defines a pose for the Robot to navigate to. A navigation goal performs the following functions:
  - A point from which the Robot performs inspections.
  - A tool to control the path of the Robot in a mission.
  - A starting point for the docking procedure.

- **Navigation zone**: a collection of navigation goals with the same location, but different orientations.
- **Inspection point**: defines the location and type of a point of interest to inspect.

Points of interest are stored in a ***.yaml*** file, which by default is stored in the data package ***environment_data/environments/*** folder.

6.9.1 Define an inspection point using an inspection tag

An inspection point is linked to one or multiple navigation zones. If the Robot is instructed to perform an inspection, it will navigate to the closest navigation goal in the first navigation zone. If the inspection from that location fails, the Robot tries again from the closest navigation goal in the second navigation zone, and so on. The inspection is only unsuccessful if the Robot tried all associated navigation zones.

> **Notice**
> It is not possible for the operator to configure the order of navigation zones for the Robot to inspect.

To create an inspection point with an associated navigation zone and navigation goal:

1. Print an inspection tag from the **ANYmal Portal**.
   Navigate to https://code.anymal.com/anymal/downloads/-/tree/master/inspection and print ***inspection_setup_tags.pdf***. For more information, follow the instructions in the ***readme.md*** file.
2. From the operator GUI, select ☰.
3. Select the **Environment Editor**.
   The Environment Editor opens.
4. Add a navigation goal:

   a. Using the ANYbotics Workflow app or operator computer, walk the Robot to the point where it should inspect the point of interest.
   b. From the **Type** dropdown menu, select **Navigation Goal**.
   c. Enter a label in the **Label** box.
      It will be used in the 3D visualization and the mission report.
   d. Enter a name in the **Name** box.

   > **Notice**
   > The name serves as item id and must be unique across all items in the environment.

   e. Select **Pose refresh** to query the current Robot pose. Ensure the **Position** and **Orientation** values are updated.
   f. Select **Save as New** to add the navigation goal. Ensure it appears in the **Database**.

5. Add a navigation zone linked to the navigation goal created in step 4:

   a. From the **Type** dropdown menu, select **Navigation Zone**.
   b. In the **Label** box, enter a label.
      It will be used in the 3D visualization and the mission report.
   c. In the **Name** box, enter a name.

> **Notice**
> The name serves as item id and must be unique across all items in the environment.

   d. Select the navigation goal created in step 4 from the **Navigation Goals** list.
   e. Select **Save as New** to add the navigation zone. Ensure it appears in the **Database**.

6. Start the inspection setup:

> **Notice**
> Inspection setup can only be started if the Robot is in **MANUAL** or **RCU** control mode.
> ▶ *For more information, see "8.2 How to manage control of the Robot" on page 200*

   a. From the **Inspection setup** area, select **Start**.
   b. From the **Sensor panel**, select the inspection payload zoom camera dialog.

7. Add an inspection point linked to the navigation zone created in step 5:

   a. From the **Type** dropdown menu, select the type of inspection you want to perform.
   b. In the **Label** box, enter a label.
      It will be used in the 3D visualization and the mission report.
   c. In the **Name** box, enter a name.

> **Notice**
> The name serves as item id and must be unique across all items in the environment.

   d. Select the navigation zone created in step 5 from the **Navigation Zones** list.
   e. Hold the inspection setup tag in front of the item to inspect.

f. In the **Environment Editor**, use the **Center** and **Zoom** inspection payload controls to ensure that the tag is visible in the zoom camera dialog.
g. Select **Pose** refresh to query the current pose of the tag.
Ensure the **Position** and **Orientation** values are updated.
h. Select **Save as New** to add the inspection point.
Ensure the inspection point appears in the **Database**.
Ensure the **Position** and **Orientation** values are updated.
i. Select **Save as New** to save the points of interest to a file for future use.

6.9.2 Define an inspection point using the 3D visualization panel

An inspection point is linked to one or multiple navigation zones. If the Robot is instructed to perform an inspection, it will navigate to the closest navigation goal in the first navigation zone. If the inspection from that location fails, the Robot tries again from the closest navigation goal in the second navigation zone, and so on. The inspection is only unsuccessful if the Robot tried all associated navigation zones.

> **Notice**
> It is not possible for the operator to configure the order of navigation zones for the Robot to inspect.

You can use the 3D visualization panel to create an inspection point in the following situations:

- The Robot is in simulation.
- You cannot reach the inspection point with the QR tag.

To create an inspection point with an associated navigation goal, do the following:

1. Move the interaction marker to the position and orientation.
2. Select ☰.
3. Select the **Environment Editor**.
   The Environment Editor opens.
4. From the **Type** drop-down, select **Navigation Goal**.
5. To query the interaction marker position, select .
6. Make sure the position was updated.
7. Complete the **Label** and **Name** fields.
8. Select **Save as New**.

To create an inspection point for inspection items, do the following:

1. Select ☰.
2. Select the **Environment Editor**.
   The Environment Editor opens.
3. Select the type of inspection item you want to create, for example, **Visual Inspection Simple**.
4. To search for the point, select ▶.

5. In the 3D visualization, select **Publish Point** tool in **Tools** menu.
6. Select the object to inspect it.
7. Make sure the position was updated.
8. Complete the **Label** and **Name** fields.
9. Select **Save as New**.

6.9.3 Define an inspection point using the ANYbotics Workforce app

Using the ANYbotics Workforce app, you can create an inspection point and associate a navigation goal and navigation zone.

An inspection point is linked to one or multiple navigation zones. If the Robot is instructed to perform an inspection, it will navigate to the closest navigation goal in the first navigation zone. If the inspection from that location fails, the Robot tries again from the closest navigation goal in the second navigation zone, and so on. The inspection is only unsuccessful if the Robot tried all associated navigation zones.

> **Notice**
> It is not possible for the operator to configure the order of navigation zones for the Robot to inspect.

> **Tip**
> To define an inspection point, you must have defined the navigation goal you want to use.
>
> ► *For more information, see "6.9.4 Define a navigation goal using the ANYbotics Workforce app" on page 145*

> **Tip**
> You can configure an inspection point without entering all the position information. Create the inspection point following the procedure below, but for step 8 set the position values to `0`. To add the position information later, use the search bar to find the inspection point thenupdate the position values.

1. Walk the robot to the desired position.
2. In the 3D map, confirmed there is a navigation goal at the desired position. If there is not, define a navigational goal.

► *For more information, see "6.9.4 Define a navigation goal using the ANYbotics Workforce app" on page 145*

3. From the operator task menu (), select to open the operator task page.
4. From the **Item type** menu, select **Inspection**.

5. Select the inspection type.
6. In **Set POI position**, select **Use April Tag**.
   The April tag is displayed.
7. Select the **tag size** then select **Find tag**.
   The robot scans for the April tag. When the robot finds the April tag, a green box is displayed around the April tag in the ANYbotics Workforce app.
8. Select **Use Position**.
   The position information is entered automatically in the **Set POI position** fields.
9. In **Set details**, enter the details of the inspection point.
10. In **Set navigation zone**, select the navigation zone you want to use.
11. In **Name**, enter a name for the inspection point.

> **Notice**
> The name serves as item id and must be unique across all items in the environment.

12. In **Set environment file path**, enter the file name to save the environment items file.
13. Select **Create**.
    The operator task page displays a confirmation notification. The new inspection point has been saved.

The inspection points are displayed in the 3D map.

► *For more information, see "3.2.7.2 Environment objects" on page 86*

6.9.4 Define a navigation goal using the ANYbotics Workforce app

You can create a navigation goal in the ANYbotics Workforce app. This allows you to create an inspection point and navigation zone.

1. Walk the robot to the desired position.
2. From the operator task menu (), select  to open the operator task page.
3. From the **Item type** menu, select **Navigation Goal**.
4. In **Set Robot Pose**, select **Use Current Pose**.
5. In **Set tolerance**, enter the **Translation** and **Rotation**.
6. In **Name**, enter a name for the navigation goal.

> **Notice**
> The name serves as item id and must be unique across all items in the environment.

7. In **Set environment file path**, enter the file name to save the environment items file.

8. Select **Create**.
   The operator task page displays a confirmation notification. The new navigation goal has been saved. A navigation zone has also been created automatically.

The navigation goals are displayed in the 3D map with a green marker icon ( ).

▶ *For more information, see "3.2.7.2 Environment objects" on page 86*

6.9.5 Configure the docking station in the operation environment

> **Notice**
> Before configuring the docking station in the operation environment, move the Robot to a location approximately 1 m from the docking station.
> The docking station should be located where the Robot will start and complete autonomous missions.

> **Notice**
> Before configuring the docking station in the operation environment, ensure the Robot is localized in the operation environment.

> **Notice**
> Before selecting **Fix to the ground**, make sure the docking station is fixed to the ground.

To use the autonomous charging system, you must configure a docking station.

▶ *For more information, see "2.3.19 Autonomous charging system " on page 69*

To allow the Robot to charge autonomously using a docking station, you must do the following:

- Configure the location of the docking station.
  This allows you to see the location of the docking station in the 3D view and can help the Robot to initialize its localization system.
- Configure the docking station navigation goal.
  This ensures that the Robot knows where to navigate to start the docking procedure.

To configure the docking station, perform the following steps:

1. Navigate the Robot to within 1 m of the docking station.
2. Rotate the Robot such that its front sensors can perceive the docking station.
   You can check this by enabling the front depth cameras in the operator GUI.
3. Select .

4. Select the **Environment Editor**.

   The Environment Editor opens.
5. From the **Database** list, select **DockingStation**.

   If you can't find it, filter the objects by the **docking_station** category.
6. From the **Docking station** section, select **Detect** to start the detection procedure.

   If the detection is successful, a green check mark appears for 2 s. Otherwise, a white cross appears for 2 s.
   If a white cross appears, move the Robot to give it a better view on the docking station, and try again.
7. If the docking station is fixed to the ground in the environment, in the **Docking station** section, select **Fixed to the ground**.

> **Notice**
>
> Before selecting **Fix to the ground**, make sure the docking station is fixed to the ground.

   This can help the Robot to initialize its localization system by looking for the docking station nearby.
8. Select **Save as Edit** to save the docking station location.

   The 3D view shows the docking station at the new location.
9. From the **Database** list, select the **DockingNavigationGoal**.

   If you can't find it, filter the objects by the **navigation_goal** category.
10. In **Navigation Goal** section, select **Pose**.

    This sets the location of the navigation goal to the current location of the Robot. From this location the Robot can detect the docking station.
11. If the docking station is fixed to the ground in the environment, in the **Docking station** section, select **Fixed to the ground**.

> **Notice**
>
> Before selecting **Fix to the ground**, make sure the docking station is fixed to the ground.

12. Select **Save as Edit** to save the location of the docking station navigation goal.

    The 3D view shows the docking station navigation goal at the new location.

> **Notice**
>
> If **Fix to the ground** is selected in step 7 or step 11, when the Robot undocks, it uses the docking station location to find an initial pose on the global map. When the Robot has localized, it can start its mission.

6.9.6 Configure the docking station in the operation environment using the ANYbotics Workforce app

1. Walk the robot to the desired position.
2. From the operator task menu (), select to open the operator task page.
3. From the **Item type** menu, select **Docking station**.
4. In **Set Robot Pose**, select the navigation goal which the robot will use to detect the docking station.
5. In **Set tolerance**, enter the **Translation** and **Rotation**.
6. If the docking station is fixed to the ground in the environment, in the **Docking station** section, select **Fixed to the ground**.

> **Notice**
>
> Before selecting **Fixed to the ground**, make sure the docking station is fixed to the ground.

   This can help the Robot to initialize its localization system by looking for the docking station nearby.
7. In **Set environment file path**, enter the file name to save the environment items file.
8. Select **Create**.

   The operator task page displays a confirmation notification. The new inspection point has been saved.

6.9.7 Configure an auditive frequency inspection point

The auditive frequency inspection point performs a frequency analysis to detect the specified frequencies. The inspection outputs the frequency spectrum and the recorded audio.

To configure a new auditive frequency inspection point, follow these steps:

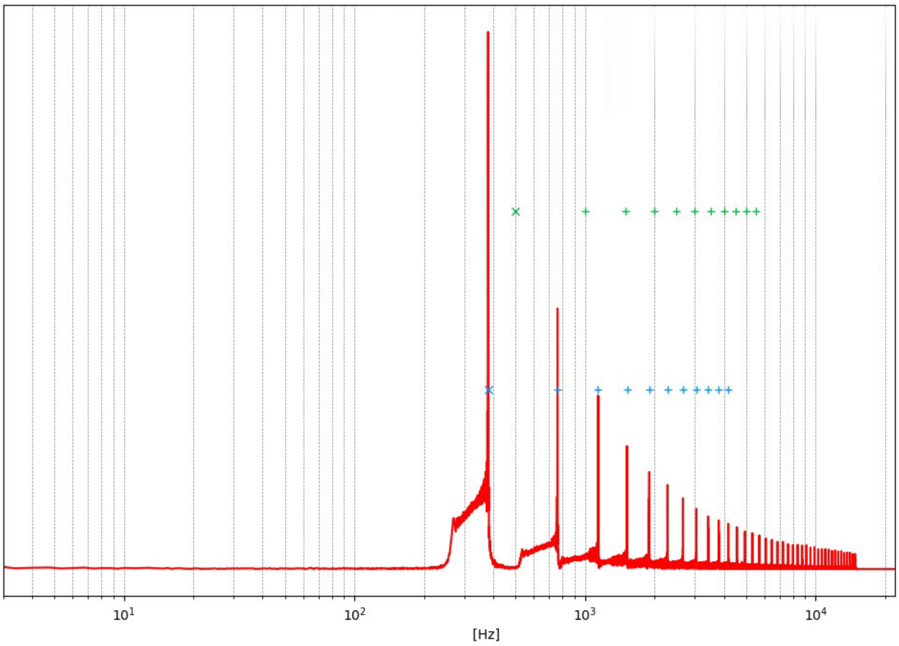
1. From the operator GUI, select .
2. Select the **Environment Editor**.

   The Environment Editor opens.
3. Start the **Inspection setup**.
4. From the dropdown, select **Auditive Inspection Frequency**.
5. Configure the options for the auditive frequency inspection point.
6. Select **Save as New** to add the new auditive frequency inspection point.
   - *For more information, see "6.3 Synchronize environment data package files" on page 124*

Table 18 - Options for an auditive frequency inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Continuous	Select if you have a mission task that runs continuously. The inspection will not stop once the frequency is detected. Set **Timeout** to `0.0` in this case.
Recording length	Define the maximum time to be recorded. The actual recording length can be shorter depending on how fast the frequency was detected.
Timeout	Define the maximum time for detecting the frequency.
Frequency range	Select between two ranges: ▪ **normal**: hearable for humans ▪ **ultrasonic**: includes the ultrasonic range.
Fundamental frequencies	Define at least one frequency to be detected. Add more frequencies after a comma.
Use harmonics	Select to include the harmonics of the fundamental frequencies in the detection.
Filter frequencies	Define at least one frequency to be filtered for the SNR calculation. This is optional and you can leave it empty.
Use filter harmonics	Select to include the harmonics of the filter frequencies.
SNR threshold	Define the SNR (signal-to-noise ratio) threshold. If the SNR is larger than the threshold, the frequencies are considered detected.
Min certainty	Define the minimum certainty of the inspection for it to be valid.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

The results of the inspection are presented in a diagram:



—	Frequency analysis
x	Fundamental frequencies
+	Harmonics
x	Fundamental frequencies (filtered)
+	Harmonics (filtered)

Figure 42 - An example result of the frequency analysis

6.9.8 Configure a thermal inspection point

The thermal inspection point measures the temperature at the given location. The inspection outputs the measured temperature, the colored and raw thermal image.

To configure a new thermal inspection point, follow these steps:

1. From the operator GUI, select .
2. Select the **Environment Editor**.
   The Environment Editor opens.
3. Start the **Inspection setup**.
4. From the dropdown, select **Visual Inspection Thermal**.
5. Configure the options for the thermal inspection point.
6. Select **Save as New** to add the new thermal inspection point.
   - ▶ *For more information, see "6.3 Synchronize environment data package files" on page 124*

Table 19 - Options for a thermal inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Unit	Select the units used to calculate the temperature. Currently, the thermal inspection always returns temperatures in degrees Celsius.
Min certainty	Define the minimum certainty of the inspection for it to be valid.
Measured temperature	Select which temperature should be measured: ■ **Min**: minimum ■ **Max**: maximum ■ **Spot**: central As an option, the measured temperature can be compared to the operating range.
Region of interest diameter [m]	Select this option to define the diameter of a circular region of interest in meters. Only this region will be colored.
Operating range (optional)	Select this option to define the standard operating range in degrees Celsius. Temperatures above and below this range will reported as an anomaly.
Colorize range (optional)	Select this option to define the temperature range that should be colored. Temperatures above and below this range will be shown in grayscale.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

6.9.9 Configure an analog gauge inspection point

The analog gauge inspection point reads an analog gauge and outputs the measurement. The analog gauge needs to be round or square.

Notice

The analog gauge inspection point cannot read gauges with non-linear scales.

To configure a new analog gauge inspection point, follow these steps:

1. From the operator GUI, select ☰.
2. Select the **Environment Editor**.

The Environment Editor opens.

3. Start the **Inspection setup**.
4. From the dropdown, select **Inspection Intelligence**.
5. From the **Type** dropdown, select **analog_gauge**.
6. Configure the options for the analog gauge inspection point.
7. Select **Save as New** to add the new analog gauge inspection point.
   - *For more information, see "6.3 Synchronize environment data package files" on page 124*

Table 20 - Options for an analog gauge inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Unit	The unit of the measurement.
Min certainty	Define the minimum certainty of the inspection for it to be valid.
Normal operating range	Define the standard operating range of the analog gauge. Measurements above and below this range will reported as an anomaly.
Measurement range	The full measurement range of the analog gauge.
Size	The size of the object in meters.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

6.9.10 Configure a digital counter inspection point

The digital counter inspection point reads a digital counter and outputs the value.

> **Notice**
> The analog gauge inspection point cannot read gauges with non-linear scales.

To configure a new digital counter inspection point, follow these steps:

1. From the operator GUI, select ☰.
2. Select the **Environment Editor**.
   The Environment Editor opens.
3. Start the **Inspection setup**.
4. From the dropdown, select **Inspection Intelligence**.

5. From the **Type** dropdown, select **digital_counter**.
6. Configure the options for the digital counter inspection point.
7. Select **Save as New** to add the new digital counter inspection point.
   - *For more information, see "6.3 Synchronize environment data package files" on page 124*

Table 21 - Options for a digital counter inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Unit	The unit of the measurement.
Min certainty	Define the minimum certainty of the inspection for it to be valid.
Normal operating range	Define the standard operating range of the digital counter. Measurements above and below this range will reported as an anomaly.
Measurement range	The full measurement range of the digital counter.
Size	The size of the object in meters.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

6.9.11 Configure a fire extinguisher inspection point

The fire extinguisher inspection point checks if a fire extinguisher exists at the specified location. If there is a fire extinguisher, the inspection output is `1`. Otherwise, the output is `0`.

To configure a new fire extinguisher inspection point, follow these steps:

1. From the operator GUI, select .
2. Select the **Environment Editor**.
   The Environment Editor opens.
3. Start the **Inspection setup**.
4. From the dropdown, select **Inspection Intelligence**.
5. From the **Type** dropdown, select **fire_extinguisher**.
6. Configure the options for the fire extinguisher inspection point.
7. Select **Save as New** to add the new fire extinguisher inspection point.
   - *For more information, see "6.3 Synchronize environment data package files" on page 124*

Table 22 - Options for a fire extinguisher inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Unit	The unit of the measurement.
Min certainty	Define the minimum certainty of the inspection for it to be valid.
Size	The size of the object in meters.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

6.9.12 Configure a lever valve inspection point

The lever valve inspection point reads the state of a lever valve. If the lever valve is opened, the inspection output is `1`. If the lever valve is closed, the output is `0`.

> **Notice**
> If the lever valve is half opened/closed, the output of the inspection will not be reliable.

To configure a new lever valve inspection point, follow these steps:

1. From the operator GUI, select ☰.
2. Select the **Environment Editor**.
   The Environment Editor opens.
3. Start the **Inspection setup**.
4. From the dropdown, select **Inspection Intelligence**.
5. From the **Type** dropdown, select **lever_valve**.
6. Configure the options for the lever valve inspection point.
7. Select **Save as New** to add the new lever valve inspection point.
   ▶ *For more information, see "6.3 Synchronize environment data package files" on page 124*

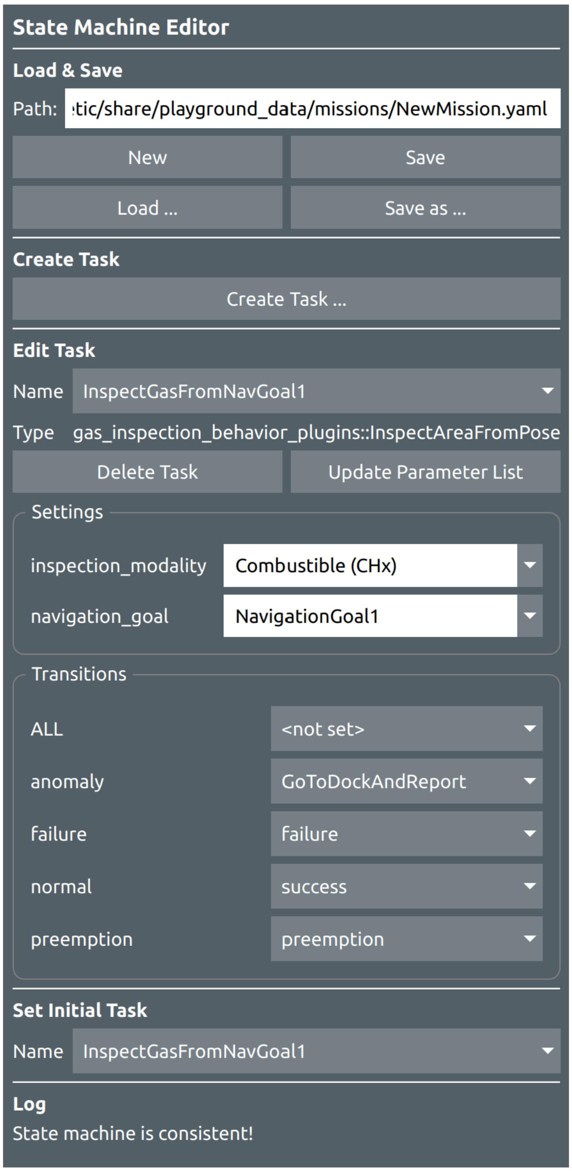
Table 23 - Options for a lever valve inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Unit	The unit of the measurement.
Min certainty	Define the minimum certainty of the inspection for it to be valid.
Normal state	Select the normal operation state of the lever valve: • Select **open** if normally the valve must be open. • Select **closed** if normally the valve must be closed. • Select both if it doesn't matter. • Select none to not check the normal operation state.
Size	The size of the object in meters.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

6.9.13 Configure a discrete gas inspection point

To configure a new discrete gas inspection point, follow these steps:

1. From the operator GUI, select ☰.
2. Select the **Mission Editor**.
   The Mission Editor opens.



3. In **Load and Save**, choose the mission to which you want to add a discrete gas inspection task:
   - To add the task to an existing mission, select **Load...** and navigate to the mission file.
   - To add the task to a new mission, select **New** and follow the steps to create a mission.
   - ▶ *For more information, see "6.10.1 Create a mission" on page 159*
4. Select **Create Task** and use one of the following task types:
   - To inspect the gas concentration in the area that the robot is at the moment, select ***gas_inspection_behavior_plugins > Inspect Area From Here***.
   - To command the robot to go to a specific navigation goal and inspect the gas concentration there, select ***gas_inspection_behavior_plugins > Inspect Area From Pose***.
5. When prompted, give the task a descriptive name.
6. Select the **inspection_modality**. You can choose one of the following:
   - **Combustible (CHx)**: inspects for combustible gas.

- **Toxic (H2S)**: inspects for toxic gas.

7. If you are using the **Inspect Area From Pose** task type, select the **navigation_goal** where you want the robot to perform the inspection.
8. In **Transitions**, select what action the robot should perform in the event of different gas detection readings.

   Gas sensor readings trigger the following transitions:
   - **anomaly**: the robot detects a medium or high gas concentration.
   - **failure**: the robot cannot receive measurements from the sensor.
   - **normal**: the robot detects a low gas concentration.

   ▶ *For more information, see "6.10.1 Create a mission" on page 159*
9. Select **Save**.

   The updated mission is saved in the Environments directory.

6.9.14 Configure a static video recording inspection point

The static video recording inspection takes a video of a point of interest or view from a selected camera. The inspection outputs the generated video recording.

To configure a new static video recording inspection point, follow these steps:

1. From the operator GUI, select .
2. Select the **Environment Editor**.

   The Environment Editor opens.
3. Start the **Inspection setup**.
4. From the dropdown, select **Visual Inspection Static Video Recording**.
5. Configure the options for the static video recording inspection point.
6. Select **Save as New** to add the new static video recording inspection point.

   ▶ *For more information, see "6.3 Synchronize environment data package files" on page 124*

Table 24 - Options for a static video recording inspection point

Label	Define how the point is named.
Name	Define the ID name for the point.
Frame ID	The frame of the inspection point pose. Leave as default.
Camera Type	Select the camera to use to inspect the point or Robot pose. Currently, the function supports these cameras: ■ **Zoom** ■ **Wide-Angle Front** ■ **Wide-Angle Rear** ■ **Thermal (colored)** ■ **Thermal (raw lossless**
Record Audio	Select if the camera also records audio using the microphone.

Duration	Select the time for which the camera records, in seconds.
Size	The size of the object in meters.
Pose	Select this option to change the pose of the inspection point. From the inspection payload control panel, select **Pose** to get the pose from the inspection tag.
Navigation zones	Select the navigation zone(s) from which the Robot can use the inspection point.

6.10 Program a mission

Once paths and points of interest have been defined, a mission can be created. This allows the Robot to navigate and inspect autonomously.

Missions are stored in ***.yaml*** files in the ***environment_data/missions/*** folder.

Use the **Mission Editor** to create and edit missions within the current ANYmal work environment.

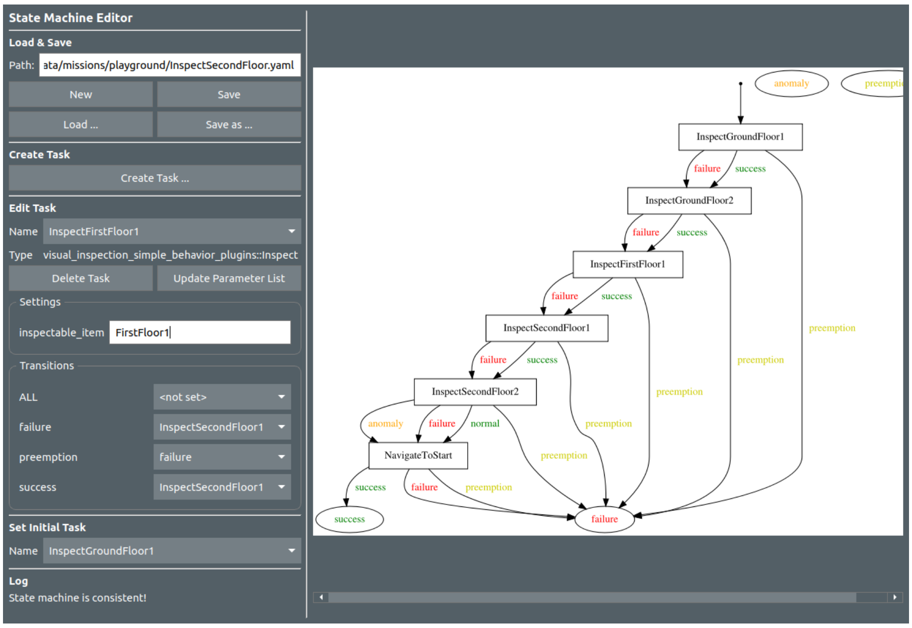


Figure 43 - This figure shows the interface of the mission editor

6.10.1 Create a mission

To create a new mission:

1. From the operator graphical user interface (GUI), select the **Mission Editor**.
2. Select **New**.

> **Notice**
> A red error message will be displayed in the **Log** area as long as your mission is invalid. Hovering the mouse over the error message will display more information.

3. Create mission tasks by following these steps:
   a. Select **Create Task** to create a mission task.
   b. In the **Task Name** box, enter the name of the task.

c. From the **Task Type** list, select one of the following depending on the type of task being created.
d. Select **OK**.
e. The new task will appear in the **Edit Task** list, **Set Initial Task** list, and in the visualization of your mission.
f. To add more mission tasks, repeat these steps.

4. From the **Set Initial Task** list, select the mission task to be executed first.
5. Configure mission tasks by following these steps:

a. From the **Edit Task** list, select the initial mission task.
b. Under **Settings**, configure the parameters of your task.
c. If the Robot work environment is configured correctly, item and goal suggestions will appear as you type. Select **Update Parameter List** if they do not.
d. Under the **Transitions** section, configure how to continue the mission in case of the different outcomes of the task.
For every task outcome, you have to choose to either continue with another task, or to stop the mission by selecting **success** or **failure**.
e. To configure other mission tasks repeat these steps.

> **Notice**
> When all mission tasks are configured correctly, the **Log** message will turn black and display "`State machine is consistent!`".

6. Select **Save** or **Save as** to save the mission.

> **Notice**
> Inconsistent missions can be saved but cannot be started.

An existing mission can be loaded by entering the path to the ***.yaml*** mission file in the **Path** box and selecting **Load** button.

6.10.2 Mission tasks

Tasks do not require you to set any preconditions. For example, you can directly command the Robot that is currently docked to inspect a point of interest. The Robot will automatically undock, enter the walk operational mode, and navigate to the corresponding location to perform the inspection.

> **Notice**
> Dial inspection tasks are deprecated. Use inspection intelligence tasks instead.

Table 25 - List of inspection tasks involving taking a picture

Name	Category	Description	Parameters	Outcomes
Inspect	visual_ inspection_ simple_ behavior_ plugins	Take a visual or thermal picture of a given object, trying out different navigation zones until the inspection is successful.	Inspectable item	**Success**: Took the picture. **Failure**: Failed to take the picture, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromHere	visual_ inspection_ simple_ behavior_ plugins	Take a visual or thermal picture of a given object from the current location.	Inspectable item	**Success**: Took the picture. **Failure**: Failed to take the picture, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromPose	visual_ inspection_ simple_ behavior_ plugins	Take a visual or thermal picture of a given object from a given navigation goal.	Inspectable item Navigation goal	**Success**: Took the picture. **Failure**: Failed to take the picture, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
InspectFromZone	visual_ inspection_ simple_ behavior_ plugins	Take a visual or thermal picture of a given object from a given navigation goal.	Inspectable item Navigational goal	**Success**: Took the picture. **Failure**: Failed to take the picture, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 26 - List of inspection intelligence tasks

Notice

The inspection intelligence tasks group a set of advanced visual inspection and interpretation tasks:

- Analog gauges
- Digital counters
- Lever valves
- Fire extinguishers

Name	Category	Description	Parameters	Outcomes
Inspect	visual_ inspection_ simple_ behavior_ plugins	Visually inspect a given object, trying out different navigation zones until the inspection is successful.	Inspectable item	**Normal**: Inspected the object, and reading was inside the expected operating range. **Anomaly**: Inspected the object, and reading was outside the expected operating range. **Failure**:Failed to inspect the object, for example, due to all paths to all navigation zones being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromHere	visual_ inspection_ simple_ behavior_ plugins	Visually inspect a given object from the current location.	Inspectable item	**Normal**: Inspected the object, and reading was inside the expected operating range. **Anomaly**: Inspected the object, and reading was outside the expected operating range. **Failure**:Failed to inspect the object, for example, due to all paths to all navigation zones being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
InspectFromPose	visual_ inspection_ simple_ behavior_ plugins	Take a visual or thermal picture of a given object from a given navigation goal.	Inspectable item Navigation goal	**Normal**: Inspected the object, and reading was inside the expected operating range. **Anomaly**: Inspected the object, and reading was outside the expected operating range. **Failure**:Failed to inspect the object, for example, due to all paths to all navigation zones being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromZone	visual_ inspection_ simple_ behavior_ plugins	Take a visual or thermal picture of a given object from a given navigation goal.	Inspectable item Navigation goal	**Normal**: Inspected the object, and reading was inside the expected operating range. **Anomaly**: Inspected the object, and reading was outside the expected operating range. **Failure**:Failed to inspect the object, for example, due to all paths to all navigation zones being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 27 - List of inspection tasks that analyze heat sources

Name	Category	Description	Parameters	Outcomes
Inspect	visual_ inspection_ simple_ behavior_ plugins	Thermally inspect a given heat source, trying out different navigation zones until the inspection is successful.	Inspectable item	**Normal**: Inspected the heat source, and reading was inside the expected operating range. **Anomaly**: Inspected the heat source, and reading was outside the expected operating range. **Failure**: Failed to take the picture, for example, due to all paths to the closest navigation goal within the given zone being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromHere	visual_ inspection_ simple_ behavior_ plugins	Thermally inspect a given heat source from the current location.	Inspectable item	**Normal**: Inspected the heat source, and reading was inside the expected operating range. **Anomaly**: Inspected the heat source, and reading was outside the expected operating range. **Failure**: Failed to take the picture, for example, due to all paths to the closest navigation goal within the given zone being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
InspectFromPose	visual_ inspection_ simple_ behavior_ plugins	Thermally inspect a given heat source from a given navigation goal.	Inspectable item Navigation goal	**Normal**: Inspected the heat source, and reading was inside the expected operating range. **Anomaly**: Inspected the heat source, and reading was outside the expected operating range. **Failure**: Failed to take the picture, for example, due to all paths to the closest navigation goal within the given zone being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromZone	visual_ inspection_ simple_ behavior_ plugins	Thermally inspect a given heat source from a given navigation zone.	Inspectable item Navigation goal	**Normal**: Inspected the object, and reading was inside the expected operating range. **Anomaly**: Inspected the object, and reading was outside the expected operating range. **Failure**:Failed to inspect the object, for example, due to all paths to all navigation zones being blocked, or the view being obstructed or suboptimal. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 28 - List of inspection tasks that record audio

Name	Category	Description	Parameters	Outcomes
Inspect	auditive_ inspection_ simple_ behavior_ plugins	Record an audio sample of a given object, trying out different navigation zones until the inspection is successful.	Inspectable item	**Success**: Recorded the audio sample. **Failure**: Failed to record the audio sample, for example, due to internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromHere	auditive_ inspection_ simple_beha-vior_plugins	Record an audio sample of a given object from the current location.	Inspectable item	**Success**: Recorded the audio sample. **Failure**: Failed to record the audio sample, for example, due to internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromPose	auditive_ inspection_ simple_beha-vior_plugins	Record an audio sample of a given object from a given navigation goal.	Inspectable item Navigation goal	**Success**: Recorded the audio sample. **Failure**: Failed to record the audio sample, for example, due to internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
InspectFromZone	auditive_ inspection_ simple_behavior_plugins	Record an audio sample of a given object from a given navigation zone.	Inspectable item Navigation goal	**Success**: Recorded the audio sample. **Failure**: Failed to record the audio sample, for example, due to internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 29 - List of inspection tasks that analyze audio frequencies

Name	Category	Description	Parameters	Outcomes
Inspect	auditive_inspection_frequency_behavior_plugins	Analyze audio frequencies of a given object, trying out different navigation zones until the inspection is successful.	Inspectable item	**Normal**: Analyzed audio frequencies, and reading was inside the expected operating range. **Anomaly**: Analyzed audio frequencies, and reading was outside the expected operating range. **Failure**: Failed to analyze audio frequencies, for example, due to all paths to the closest navigation goal within the given zone being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromHere	auditive_inspection_frequency_behavior_plugins	Analyze audio frequencies of a given object from the current location.	Inspectable item	**Normal**: Analyzed audio frequencies, and reading was inside the expected operating range. **Anomaly**: Analyzed audio frequencies, and reading was outside the expected operating range. **Failure**: Failed to analyze audio frequencies, for example, due to all paths to the closest navigation goal within the given zone being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
InspectFromPose	auditive_inspection_frequency_behavior_plugins	Analyze audio frequencies of a given object from a given navigation goal.	Inspectable item Navigation goal	**Normal**: Analyzed audio frequencies, and reading was inside the expected operating range. **Anomaly**: Analyzed audio frequencies, and reading was outside the expected operating range. **Failure**: Failed to analyze audio frequencies, for example, due to all paths to the closest navigation goal within the given zone being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromZone	auditive_inspection_frequency_behavior_plugins	Analyze audio frequencies of a given object from a given navigation zone.	Inspectable item Navigation goal	**Normal**: Analyzed audio frequencies, and reading was inside the expected operating range. **Anomaly**: Analyzed audio frequencies, and reading was outside the expected operating range. **Failure**: Failed to analyze audio frequencies, for example, due to all paths to the closest navigation goal within the given zone being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 30 - List of gas inspection tasks

Name	Category	Description	Parameters	Outcomes
InspectFromHere	gas_inspection_behavior_plugins	Measure a gas concentration from the current location.	Inspection modality (gas type)	**Normal**: Measured gas concentration, and reading was low. **Anomaly**: Measured gas concentration, and reading was medium or high. **Failure**: Failed to measure gas concentration, for example, due to an internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromPose	gas_inspection_behavior_plugins	Measure a gas concentration at a given navigation goal.	Inspection modality (gas type) Navigation goal	**Normal**: Measured gas concentration, and reading was low. **Anomaly**: Measured gas concentration, and reading was medium or high. **Failure**: Failed to measure gas concentration, for example, due to an internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 31 - List of inspection tasks involving taking a static video recording

Name	Category	Description	Parameters	Outcomes
Inspect	visual_inspection_video_recording_behavior_plugins	Take a visual or thermal static video recording of a given object, trying out different navigation zones until the inspection is successful.	Inspectable item	**Success**: Took the video recording. **Failure**: Failed to take the recording, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromHere	visual_inspection_video_recording_behavior_plugins	Take a visual or thermal static video recording of a given object from the current location.	Inspectable item	**Success**: Took the video recording. **Failure**: Failed to take the recording, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
InspectFromPose	visual_inspection_video_recording_behavior_plugins	Take a visual or thermal static video recording of a given object from a given navigation goal.	Inspectable item Navigation Goal	**Success**: Took the video recording. **Failure**: Failed to take the recording, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.
InspectFromZone	visual_inspection_video_recording_behavior_plugins	Take a visual or static video recording picture of a given object from a given navigation zone.	Inspectable item Navigation Goal	**Success**: Took the video recording. **Failure**: Failed to take the recording, for example, due to all paths to all navigation zones being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 32 - List of navigation tasks

Name	Category	Description	Parameters	Outcomes
ReactiveNavigation	navigation_behavior_plugins	Navigate to a given navigation goal.	Navigation goal	**Success**: The goal was reached. **Failure**: Failed to reach the goal, for example, due to all possible paths being blocked. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 33 - List of system tasks

Name	Category	Description	Parameters	Outcomes
CheckBatteryLevel	system_behavior_plugins	Check if the battery level is above a specified percentage.	Battery percentage threshold	Battery above threshold. Battery below threshold. **Not OK**: Battery state is invalid. **Failure**: Failed to read battery level. **Preemption**: The task was interrupted by the Operator or system self-preservation.
CheckForLowBattery	system_behavior_plugins	Check once if the battery level is fine.	—	**OK**: Battery level is not low. **Not OK**: Battery level is low. **Disabled:**: Battery level checks are currently disabled. **Failure:**:Failed to read battery level. **Preemption**: The task was interrupted by the Operator or system self-preservation.
Dock	system_behavior_plugins	Switch to Dock Operational Mode.	—	**Success**: The Robot is docked. **Failure**: Failed to dock, for example, due to all possible paths being blocked, or the docking station not being detected. **Preemption**: The task was interrupted by the Operator or system self-preservation.
Rest	system_behavior_plugins	Switch to Rest Operational Mode.	—	**Success**: The Robot is resting. **Failure**: Failed to rest, for example, due to an internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Name	Category	Description	Parameters	Outcomes
Sleep	system_ behavior_ plugins	Switch to Sleep Operational Mode.	—	**Success**: The Robot is sleeping. **Failure**: Failed to sleep, for example, due to an internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.
Stand	system_ behavior_ plugins	Switch to Stand Operational Mode.	—	**Success**: The Robot is standing. **Failure**: Failed to stand, for example, due to an internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.
Walk	system_ behavior_ plugins	Switch to Walk Operational Mode.	—	**Success**: The Robot is ready to walk. **Failure**: Failed to walk, for example, due to an internal error. **Preemption**: The task was interrupted by the Operator or system self-preservation.

Table 34 - List of basic tasks

Name	Category	Description	Parameters	Outcomes
Sleep	basic_behavior_plugins	Sleep for a given duration.	Duration	**Success**: Slept for given duration. **Failure**: Failed to sleep. **Preemption**: The task was interrupted by the Operator or system self-preservation.

6.11 Validate setup and mission

A mission should be tested after setup to ensure it is configured correctly.

Test the mission by starting the mission from the operator GUI and closely following the Robot to supervise its behavior.

► *For more information, see "8.5.6 How to start a mission using the GUI" on page 235*

7 CONFIGURE REMOTE OPERATION

To operate the Robot remotely, you need to connect the Robot to an installed network which has been configured correctly.

7.1 Connect the Robot to an on-site wireless network

The robot can communicate over different Wi-Fi frequencies:

- 2.4 GHz
- 5 GHz
- LTE (if the Robot has an LTE module)

These are the most common router modes:

- **Access point mode**: the Robot creates its own Wi-Fi network in both frequencies. Other devices can connect to the Robot.
  In this mode, the Robot does not have internet access.
- **LTE mode**: the Robot connects to the LTE network. The two Wi-Fi frequencies are used to create access points.

> **Notice**
>
> The **LTE mode** can only be used if the Robot has an LTE module.

- **Access point with NAT mode**: the Robot uses both Wi-Fi frequencies. One frequency is used to create a Wi-Fi network, the other frequency to bridge into an existing on-site Wi-Fi network.

> **Notice**
>
> The Robot uses the `192.168.0.1/24` range internally.
>
> The routing can only work if the existing on-site Wi-Fi uses a different subnet range. Otherwise, you need to reconfigure the Robot's internal network.

> **Notice**
>
> For more advanced modes, please refer to the help of the `anymal-router` utility, that is `anymal-router --help`.
>
> To connect to the Robot over the LTE or Wi-Fi networks in NAT mode, you will require a VPN-based solution.

The Robot is shipped in **Access point mode**.

To connect the Robot to an existing Wi-Fi network, you need to:

1. Configure the router in either **Access point with NAT mode** or **LTE mode**.
   ▶ *For more information, see "7.1.1 Change the router mode" on page 182*
2. Configure the router to connect to the correct on-site network.
   ▶ *For more information, see "7.1.2 Reconfigure the network connections" on page 183*
3. Configure a VPN connection.
   ▶ *For more information, see "7.2 Configure VPN" on page 187*

> **Notice**
> A VPN must be used to comply with security standards.

7.1.1 Change the router mode

To change the operation modes of the router, use the `anymal-router` utility tool provided by the `anymal_router_utils` package.

> **Notice**
> This will cause a connection drop if you are connected to the router using Wi-Fi.

> **Tip**
> You can also connect via Ethernet cable and access use `192.168.1.1` as the `<router_ip>`.

To run the script, follow these steps:

1. Open a terminal session on the operator computer (OPC).
2. Run the following command:

```
anymal-router -i <router_ip> -p <router_password> switch-mode --mode <mode>
```

Tip

The default `<router_password>` is the name of your Robot.

Replace `<router_ip>` with the IP address of your router that you can find in the datasheet of the Robot.

`<mode>` is one of the mode options, which can be listed with `anymal-router switch-mode --help`.

7.1.2 Reconfigure the network connections

You can reconfigure the network connections by:

- Reconfiguring the Wi-Fi connection
  - ▶ *For more information, see "7.1.2.1 Reconfigure the Wi-Fi connection" on page 183*
- Reconfiguring the LTE connection
  - ▶ *For more information, see "7.1.2.2 Reconfigure the LTE connection" on page 186*

7.1.2.1 Reconfigure the Wi-Fi connection

To connect the Robot to an existing on-site Wi-Fi network, you need to change the following configurations on the Robot router:

- The SSID of the on-site network
- The correct encryption and authentication configuration

Warning

Changing the router configuration may cause a security risk.

Always check for vulnerabilities when changing the router configuration.

Only connect the Robot to secure and trusted Wi-Fi networks.

You can configure the router by:

- Using its web interface
  - ▶ *For more information, see "7.1.2.1.1 Configure the router Wi-Fi using the web interface" on page 184*
- Manually changing the router configuration files (for an advanced User)
  - ▶ *For more information, see "7.1.2.1.2 Modify the router Wi-Fi configuration manually" on page 185*

> **Notice**
>
> The Robot uses the `192.168.0.1/24` range internally.
>
> The routing can only work if the existing on-site Wi-Fi uses a different subnet range. Otherwise, you need to reconfigure the Robot's internal network.

The Wi-Fi also needs to be configured to the current location of the Robot.

▶ *For more information, see "7.1.2.1.3 Select the country code" on page 185*
▶ *For more information, see "7.1.2.1.4 Update the regulatory database" on page 186*

> **Warning**
>
> The Robot location must be correctly configured to comply with local radio regulations.

7.1.2.1.1 Configure the router Wi-Fi using the web interface

You can reconfigure the network connections using the web interface of the router.

The router is based on OpenWRT. For more information, see https://openwrt.org/.

1. Enter the router IP address into a web browser.
2. In the **Username** box, enter `root`.
3. In the **Password** box, enter the Robot name.
4. Select **Login**.
5. Select **Network** > **Wireless**.
   The **Wireless Overview** window will appear.
6. To change the preconfigured wireless profile, select **Edit**.

> **Notice**
>
> If you still want to use the `router_setup.bash` script, don't change the mode of a wireless profile.

The **Wireless Overview** window shows information for:

- **radio0** (2.4 GHz)
- **radio1** (5 GHz)

Both bandwidths have the following profiles:

- bridge (**Mode: Client**)
- access point (**Mode: Master**)

7.1.2.1.2 Modify the router Wi-Fi configuration manually

You can reconfigure the network connections by modifying the ***/etc/config/wireless*** file on the router.

To reconfigure network connections, follow these steps:

1. Open a terminal session.
2. Run the following command:

```
ssh root@<router-ip>
```

> **Tip**
>
> The default `<router_password>` is the name of your Robot.
>
> Replace `<router_ip>` with the IP address of your router.
>
> `anymal-router --help` shows the help and available commands.

3. Enter your Robot name as your password.
4. Edit the ***/etc/config/wireless*** file using a text editor.

> **Notice**
>
> If you still want to use the `anymal-router` script, you should only change the following options:
>
> - SSID
> - Key
> - Encryption

7.1.2.1.3 Select the country code

The Wi-Fi country code must be set to the location where the Robot is currently operating. This ensures that the router will only enable Wi-Fi radio settings that conform with the country's official regulatory laws.

To change the current country code of the router, run the following command:

```
anymal-router -i <router_ip> -p <router_password> configure-radio --
radio <radio> -c <country_code>
```

> **Notice**
>
> This will restart the Wi-Fi to apply the new settings.
>
> This will cause a connection drop if you are connected to the router via Wi-Fi.

> **Tip**
>
> Replace `<country_code>` with the country code for the country where the Robot is currently operating.
>
> For more information on country codes, see https://en.wikipedia.org/wiki/List_of_ISO_3166_country_codes.
>
> `anymal-router configure-radio --help` shows the help and available commands.

7.1.2.1.4 Update the regulatory database

The regulatory database stores the allowed Wi-Fi operating conditions for each country. To make sure that the router database is up-to-date, we advise that the regulatory database of the router is regularly updated.

To update the regulatory database, run the following command:

```
anymal-router -i <router_ip> -p <router_password> update-regulatory
```

> **Notice**
>
> The script requires internet access to download the latest database files from the web.
>
> If this is not feasible, a local database file can be supplied with the `-f` flag.
>
> The latest database file (`db.txt`) can be found here: https://git.kernel.org/pub/scm/linux/kernel/git/sforshee/wireless-regdb.git/tree/db.txt

7.1.2.2 Reconfigure the LTE connection

> **Notice**
>
> The **LTE mode** can only be used if the Robot has an LTE module.

To connect the Robot to a LTE network, you need to change the following configurations on the Robot router:

- The APN (Access Point Name) of the LTE module
  This should be provided by the SIM card provider.
- The PIN code
  A PIN code is needed to unlock some SIM cards.

> **Warning**
> Connecting the router via LTE may cause a security risk.
> Always check for vulnerabilities when changing the router configuration.

To configure the LTE connection:

1. Change the router mode to LTE mode.
   ▶ *For more information, see "7.1.1 Change the router mode" on page 182*
2. From the web interface, select **Network** > **Interfaces**.
3. Select **Edit** for the **LTE** interface.
   The LTE dialog box opens.
4. In the **General settings** tab, enter the data into the **APN** field.
5. Enter the data into the **PIN** field.
6. Select **Save**.
   The LTE dialog box closes.
7. From the bottom of the **Interfaces** page, select **Save & apply**.

You can configure the router by:

- Using its web interface
  ▶ *For more information, see "7.1.2.1.1 Configure the router Wi-Fi using the web interface" on page 184*
- Changing the router configuration (for an advanced User)
  ▶ *For more information, see "7.1.2.1.2 Modify the router Wi-Fi configuration manually" on page 185*

7.2 Configure VPN

> **Notice**
> A VPN must be used to comply with security standards.

The Robot is configured so that it can be operated using either the ANYbotics Workflow app, or using an an OPC configured to be in the same local network as the Robot.

The local subnet does not use public IP addresses and is behind one or multiple firewalls, so it is not possible for an OPC to communicate with the Robot directly from an external network. However, communication between the Robot and an OPC, in a different network, can be established using a Virtual Private Network (VPN).

To make this work, a computer, which is accessible from both the Robot and OPC, must be available. All traffic between OPC and the Robot is re-routed through the server.

Other traffic, such as communication between the PCs on the Robot or software updates, will not be affected and still go through the normal network interface.

Depending on the network setup, this computer might also be the OPC itself. In that case, you can skip the client setup for OPC.

This computer is referred to as the VPN server and each PC on the Robot and OPC are VPN clients.

7.2.1 Configure the VPN server

If you want to communicate with the Robot directly from an external network, you must use a VPN server.

▶ *For more information, see "3.5 VPN server" on page 100*

The following is required to install the VPN server:

- A computer with the Linux Ubuntu 20.04 operating system that meets the minimum system requirements.
- A user with `sudo` rights
- An internet connection
- A network configure with a public IP address, or an IP address which is accessible from the Robot and OPC. Ideally, there is also a domain pointing to the server.

> **Notice**
> As the traffic between OPC and the Robot is routed through the server, ensure the computer on which you install the server has a good internet connection.

To install the VPN server, follow these steps:

1. Run the following command:

   ```
   sudo apt install wireguard
   ```

   This installs the required tools.
2. Using `sudo`, open ***/etc/sysctl.conf*** with a text editor and change or uncomment the following line:

   ```
   net.ipv4.ip_forward = 1
   ```

   This enables IP forwarding so traffic can flow between OPC and the Robot.
3. If you want to work with IPv6, change or uncomment the following line:

   ```
   net.ipv6.conf.all.forwarding = 1
   ```
4. Save ***/etc/sysctl.conf***.
5. Run the following command:

   ```
   sudo sysctl --system
   ```

   This loads the new configuration.
6. Create a public and a private key for the server.

   ```
   mkdir wireguard_keys && cd wireguard_keys
   umask 077
   wg genkey | tee privatekey | wg pubkey > publickey
   ```

This will create two files, ***privatekey*** and ***publickey***, which are normal text files containing the keys.

> **Warning**
>
> Keep these keys secret, especially the private key.

7. Using `sudo`, create the file ***/etc/wireguard/wg0.conf*** with a text editor and enter the following:

```
[Interface]
Address = 10.8.0.1/24
SaveConfig = true
PostUp = iptables -A FORWARD -i wg0 -j ACCEPT; iptables -t nat -A POSTROUTING -o eth0 -j MASQUERADE; ip6tables -A FORWARD -i wg0 -j ACCEPT; ip6tables -t nat -A POSTROUTING -o eth0 -j MASQUERADE
PostDown = iptables -D FORWARD -i wg0 -j ACCEPT; iptables -t nat -D POSTROUTING -o eth0 -j MASQUERADE; ip6tables -D FORWARD -i wg0 -j ACCEPT; ip6tables -t nat -D POSTROUTING -o eth0 -j MASQUERADE
ListenPort = 51820
PrivateKey = <private key of the server>
```

   The `PostUp` and `PostDown` commands are required to correctly forward traffic between the clients. Replace any occurence of `eth0` with the interface name used on your server. You can list the interfaces with the command `ip addr`, usually the interface which has an associated IP address is the one you will need to use.

   The private key can be found in the ***privatekey*** file generated in the previous step.

8. Save ***/etc/wireguard/wg0.conf***.
9. If your server has a firewall installed, you must specify a firewall rule, as shown here for the firewall `ufw`:

```
sudo ufw allow 22/tcp
sudo ufw allow 51820/udp
sudo ufw enable
```

10. Verify the firewall settings.

```
sudo ufw status verbose
```

11. Start the server.

```
sudo wg-quick up wg0
```

12. If you want to automatically start the VPN server when the server computer boots, you can enable its system service.

```
sudo systemctl enable wg-quick@wg0.service
```

The VPN server is ready for use.

Tip

Depending on the network setup, the VPN server might be the OPC itself. If this is the case, you can omit the client setup for OPC. Each PC on the Robot and OPC are VPN clients.

7.2.2 Configure the VPN client

The following steps are required to be followed for each PC involved. Typically this means the OPC and all PCs on the Robot.

1. On each client PC, install the required tools.

```
sudo apt install wireguard
```

2. Create a public and a private key for each client.

```
mkdir wireguard_keys && cd wireguard_keys
umask 077
wg genkey | tee privatekey | wg pubkey > publickey
```

This creates two files, ***privatekey*** and ***publickey***, which are text files containing the keys.

3. Create a configuration file in ***/etc/wireguard/wg0.conf*** using your preferred text editor.

```
[Interface]
PrivateKey = <private key of the client>
Address = <Client Address>/32

[Peer]
PublicKey = <public key of the server>
Endpoint = <public IP of the server or domain>:51820
AllowedIPs = 10.8.0.0/24
PersistentKeepalive = 25
```

Assign a different <Client Address> to each client, but stay compatible with the subnet defined in the server's configuration.
Typically this means that you should only increment the number after the last address. For example, use `10.8.0.2/32` for LPC, `10.8.0.3/32` for NPC and so on.

4. On the server, run the following command to register the client:

```
sudo wg set wg0 peer <Client Public Key> persistent-keepalive 25
allowed-ips <Client Address>/32
sudo systemctl restart wg-quick@wg0.service
```

As `SaveConfig = true` in the server configuration, any client added like this is added to the server's ***/etc/wireguard/wg0.conf*** configuration file upon shutdown/restart of the service. Any changes made to the configuration file before the interface is removed will be overwritten.

5. On the client, start the VPN by running.

```
sudo wg-quick up wg0
```

6. Test the configuration by pinging the server from the client, using the VPN IP range.

```
ping 10.8.0.1
```

You can ping the other clients.

7. To automatically start the VPN client when the Robot boots, you can enable its systemd service.

```
sudo systemctl enable wg-quick@wg0.service
```

7.2.3 Configure ROS on the OPC

After configuring a VPN client on OPC, you are required to reconfigure the Robot Operating System (ROS) to make it use the VPN network.

1. Using a text editor, open the ***/etc/hosts*** file and adapt the IP addresses of the Robot PCs to use the VPN subnet. For example:

```
192.168.0.xxx     anymal-NAME-lpc
```

to

```
10.8.0.xxx       anymal-NAME-lpc
```

▶ *For more information on setting up shortcuts to contact your Robot, refer to the ANYbotics Software Guide.*

2. In the console, from which you launch the OPC software stack, export the `ROS_IP`.

```
export ROS_IP=<VPN IP of OPC>
```

3. Launch the OPC software stack, as usual.

7.3 Configure a data synchronization server

The `ads-server` package provides an infrastructure server for your network. This installs a docker-compose configuration to ***/usr/share/ads/server***, which provides the complete set of service dependencies.

7.3.1 Preconditions for the data synchronization server

To configure the data synchronization server, follow these steps:

1. To install the `ads-server` package, run the following command:

```
$ sudo apt install ads-server
```

This installs the package.

2. Go to https://code.anymal.com/-/profile/personal_access_tokens.
3. Create an access token with the scope `read_registry`.

> **Tip**
>
> For more information about authenticating with the GitLab container registry, see https://docs.gitlab.com/ee/user/packages/container_registry/authenticate_with_container_registry.html.

4. Using the token you created, execute the following command:

```
$ docker login docker.anymal.com -u <username> -p <token>
```

5. Navigate to the server directory, and build the docker-compose environment:

```
$ cd /usr/share/ads/server
$ sudo docker compose pull
```

7.3.2 Configure the data synchronization server

When an agent or a client connects to a data synchronization server, it will check the server's TLS certificate to ensure it is not communicating with an impostor.

To enable this check, follow these steps:

1. Determine the domain name or IP address under which your Robot will reach the server.

   This is referred to as `<server-address>`.
2. Obtain a TLS server certificate-chain and private key for that domain name and/or IP address.

   This can be done using your own PKI, in which case the signing root certificate must be stored on all agent and client machines.

   ▶ *For more information, refer to the ANYbotics Software Guide.*

   Alternatively, to obtain a certificate, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/. This certificate is signed with the pre-shared root certificate.
3. Store these files under ***/usr/share/ads/credentials/ads-server.crt*** and ***/usr/share/ads/credentials/ads-server.pem*** respectively.
4. If you are creating your own certificates, install the signing root certificate at ***/usr/share/ads/credentials/<server-address>-root.crt*** on any machine that may connect to your local infrastructure server.
5. Configure your Robot to connect to your local server by adding the following to the Robot configuration file on the LPC at ***/home/integration/.ros/config.yaml***:

```
stack_launcher:
  nodes:
    ads_agent_lpc:
      roslaunch:
        args: http://npc:58050 ads.local:58050 <server-address>:58050
    ads_agent_npc:
      roslaunch:
        args: http://npc:58050 ads.local:58050 <server-address>:58050
```

7.3.3 Start the server

After you have a valid server certificate installed, you can start the server using the following commands:

```
cd /usr/share/ads/server
sudo docker compose up -d
```

The server restarts when necessary, even after a machine reboot.

Along with the core functionality of the data synchronization server, a basic performance metric dashboard is available at the following address: ***http://<server-address>:3000***.

To stop the server, use the following commands:

```
cd /usr/share/ads/server
sudo docker compose stop
```

7.3.4 Change the administrator passwords

The data synchronization server has preconfigured administrator accounts with basic passwords.

You must change these passwords immediately after installation of the data synchronization server.

To change the passwords, follow these steps:

1. Change the built-in user management administrator account password, using the following commands:

   ```
   source /opt/ros/noetic/setup.bash
   ads -s <server-address>:58050 login admin
   ads -s <server-address>:58050 passwd
   ```

   This is preconfigured as `admin`.
2. Navigate to your Grafana DataSync interface at the following address: ***http://<server-address>:3000***.
3. You are prompted to change the administrator password.

7.3.5 Test without TLS

> **Caution**
> Running the data synchronization server without TLS removes all data security for the involved agents, clients and server.

It is possible to deactivate the transport layer security (TLS) for a specific server for testing purposes using the following steps:

1. On the server, configure the server to run in insecure mode and restart it.

```
$ cd /usr/share/ads/server
$ cat <<EOS | sudo tee .env
ADS_SET_SERVER_CERT=--insecure
EOS
$ docker compose up -d
```

2. On all agent and client machines that may connect to your local insecure server, create an empty (invalid) root certificate for your server.

```
$ sudo touch /usr/share/ads/credentials/<server-address>.crt
```

3. Restart the robot software.

After testing is complete, reactivate TLS using the following steps:

1. On the server, revert the file at ***/usr/share/ads/server/.env*** to:

```
$ cd /usr/share/ads/server
$ cat <<EOS | sudo tee .env
ADS_SET_SERVER_CERT=--server-cert /var/lib/ads/credentials/ads-server.crt
EOS
$ docker compose up -d
```

2. Remove any previously created empty (invalid) root certificates.

```
$ sudo rm /usr/share/ads/credentials/<server-address>.crt
```

3. Restart the Robot software.

7.3.6 Update the data synchronization server

To update the data synchronization server, run the following command for updating any packages on the server.

```
$ sudo apt update
$ sudo apt upgrade
$ sudo apt autoremove
```

After this is complete, run the following commands to update the server software:

```
$ cd /usr/share/ads/server
$ sudo docker compose pull
$ docker compose up -d
```

7.3.7 Update the supporting services

The data synchronization server depends on two supporting services:

- A TimescaleDB instance for storing file metadata and other time series data.
- A Grafana instance for visualizing the server status.

These services can be updated using the following commands:

```
$ docker compose pull
$ docker compose up -d
$ docker compose exec timescaledb psql -U postgres ads -c "ALTER EXTENSION timescaledb UPDATE;"
```

8 OPERATIONS

> **Caution**
>
> Risk of injury!
>
> Only trained personnel are allowed to use and operate the Robot.
>
> ► *For more information, see "1.1 User, Master Operators, Operators and Bystanders" on page 16*

8.1 How to charge the Robot

The Robot is powered using a Lithium-ion battery. To ensure your Robot is ready to use, re-charge your Robot battery at regular intervals.

8.1.1 How to check the Robot battery level

Before starting a mission, check the Robot battery level and confirm if it needs to be charged.

You can check the battery level in one of the following:

- The Graphical User Interface (GUI):
  - ► *For more information, see "3.2.3 Robot status panel" on page 78*
- The ANYbotics Workforce app
  - ► *For more information, see "3.3 ANYbotics Workforce app overview" on page 93*

8.1.2 How to replace the Robot battery

To replace the Robot battery, you must remove the bottom shell and brackets and remove the battery from the Robot.

It is important that you safely remove the Robot battery using the correct procedure.

► *For more information, see "4.2 Insert the Robot battery" on page 103*

8.1.3 How to charge the Robot battery externally

Caution

Risk of injury!

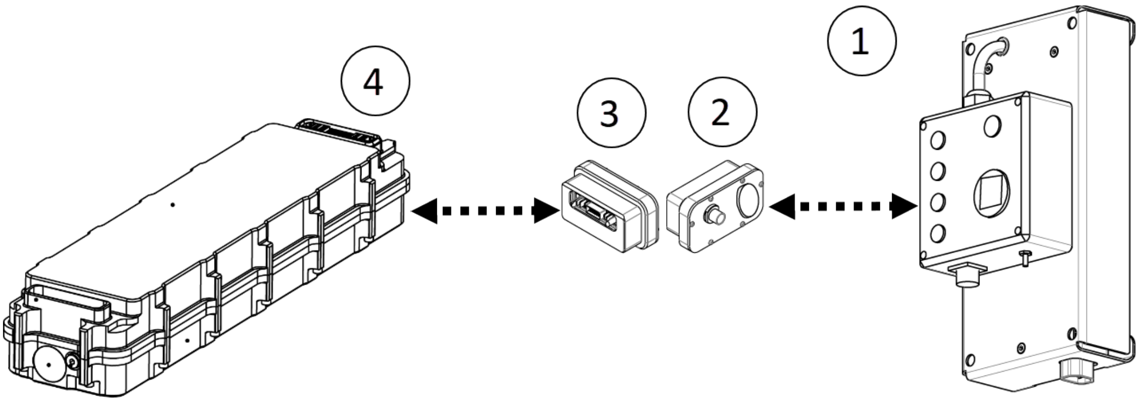
The battery charger must be installed in a sheltered area.

Do not leave the battery attached to the battery charger and charging for extended periods.

You can charge the battery externally using the battery charger:

▶ *For more information, see "2.3.18 Battery charger and adapter" on page 68*

1. Connect the battery charger (1) to the front of the battery adapter (2) using a power cable.
2. Connect the battery (4) into the back of the battery adapter (3).
3. Turn on the battery charger (1).
   The battery starts charging. When the battery charger **Full** light is on and the **Charging** light is off, the battery is fully charged.



1	Battery charger
2	Front of the battery adapter
3	Back of the battery adapter
4	Battery

Figure 44 - Charging the battery externally using the battery charger

8.1.4 How to charge the Robot battery using the charging socket

> **Caution**
>
> Risk of injury!
>
> Do not approach the Robot if the danger zone active warning light is on.

To charge the Robot battery using the charging socket on the Robot, follow these steps:

1. Ensure the Robot emergency stop is disengaged.
   - ▶ *For more information, see "1.5.2 GUI cut power" on page 22*
2. Connect the battery charger to the power socket.
3. Plug the charging cable into the dedicated socket on the battery charger.
4. Plug the charging cable into the charging socket on the top of the Robot.
   - ▶ *For more information, see "2.3.2 Connections" on page 54*
5. Turn on the battery charger.

   When the battery charger **Full** light is on and the **Charging** light is off, the battery is fully charged.

8.1.5 How to charge the Robot battery using the docking station

> **Warning**
>
> Risk of serious injury or death!
>
> The Robot operates in **Blind** mode in the following situations:
>
> - When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
> - When docking
> - When in the **crawl** motion state
>
> This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.
>
> This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.
>
> Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

> **Notice**
>
> To dock the Robot in the docking station, a docking station must be present in the operation environment.
>
> Also, the Robot must be localized or be in the vicinity of the docking station.

The Robot battery can be charged using a docking station.

- ▶ *For more information, see "2.3.19 Autonomous charging system " on page 69*

To charge the Robot battery using the docking station, follow these steps:

1. Connect the battery charger to the power socket.
2. Plug the charging cable into the dedicated socket on the battery charger.
3. Plug the charging cable into the docking station socket.
4. Turn on the battery charger.
5. Dock the Robot using Environment objects or the operational modes.

- ▶ *For more information, see "8.5.15 How to dock and undock the Robot using Environment objects" on page 246*
- ▶ *For more information, see "8.5.16 How to dock and undock the Robot using operational modes" on page 247*

8.2 How to manage control of the Robot

The control of the Robot is managed by two complementary systems, the **Control authority** and the **User interaction mode**.

To find out how to interact with them, have a look at the specific workflows for GUI or ANYbotics Workforce app.

- ▶ *For more information, see "8.2.3 How to manage control of the Robot using the GUI" on page 202*
- ▶ *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*

8.2.1 Control authority

The **Control authority** feature is an integral part of the Robot's safety system. The Robot is monitored and controlled by entities, which can be either human operators or scripts. An arbitrary number of entities can monitor the Robot's operation. The control authority mechanism ensures that only one of them can control the Robot at any time.

Once in control, an entity can perform actions such as playing or pausing missions or steering the Robot. The operator graphical user interface (GUI) and ANYbotics Workforce app usually hide or disable unavailable actions if not in control.

Control entities are categorized and prioritized as following:

Category	Description	Priority	Example
On-site	For human operators which have direct line of sight to the Robot.	Highest	ANYbotics Workforce app.
Remote	For human operators which do not have direct line of sight to the Robot.	Intermediate	Operator graphical user interface.
Automated	For automated scripts and programs which control the Robot.	Lowest	Mission scheduler.

A higher priority entity is allowed to "steal" control from a lower priority entity, i.e. it is allowed to take control without the latter releasing control first. If the entity has the same or lower priority as the entity in control, the latter first needs to release control.

If the entity in control loses connection to the Robot, its control is automatically released after 30 seconds.

For safety reasons, every entity can issue the **Protective Stop** and the **Cut Power** commands at any point in time, even if not in control. To clear them, the entity still has to take control.

- *For more information, see "8.5.1 How to activate the protective stop using the operator GUI" on page 232*
- *For more information, see "8.5.2 How to stop the Robot using the GUI cut power" on page 232*
- *For more information, see "8.3.3 How to activate the protective stop using the ANYbotics Workforce app" on page 205*
- *For more information, see "8.3.4 How to activate the cut power using the ANYbotics Workforce app" on page 205*

8.2.2 User interaction mode

The **User interaction mode** feature ensures that commands sent while running a mission and commands sent by an operator cannot conflict.

This is achieved by three exclusive user interaction modes:

User interaction mode	Description
Autonomous	The autonomous mode allows you to play or pause a mission, or execute single tasks like navigate to or inspect a given point of interest
Manual	The manual mode allows you to take over manual control of the Robot, change the operational mode, send velocity commands, control the inspection payload, etc.
Manual RCU	The manual RCU mode is a special mode which is only available in combination with the Remote Control Unit. It allows you to control the Robot using the Remote Control Unit.

8.2.3 How to manage control of the Robot using the GUI

The operator graphical user interface (GUI) can be used to manage Robot control.

► *For more information, see "8.2 How to manage control of the Robot" on page 200*

The **Control authority** button on the top left of the status bar indicates the current control authority owner and acts as an interface to take or release control:

Color	State	Description
Black	Free	No entity owns control. To take control, select the **Control authority** button.
Yellow	Foreign	A foreign entity owns control. The entity is one of the following: • **On-site** • **Remote**: indicated with a tablet icon. • **Automated**: indicated with a robot icon. If the entity is **automated**, you can take control. To take control, select the **Control authority** button.
Green	Owner	You own control which enables to you to issue commands to the Robot. To release control, select the **Control authority** button.

The **User interaction mode** button indicates the current user interaction mode. Press it to switch between the modes.

8.2.4 How to manage control of the Robot with the ANYbotics Workforce app

The ANYbotics Workforce app can be used to manage Robot control.

► *For more information, see "8.2 How to manage control of the Robot" on page 200*

The **Control authority** button on the top left of the status bar indicates the current control authority owner and acts as an interface to take or release control:

Color	State	Description
Black	Free	No entity owns control. To take control, select the **Control authority** button.
Yellow	Foreign	A foreign entity owns control. The entity is one of the following: • **On-site** • **Remote**: indicated with a tablet icon. • **Automated**: indicated with a robot icon. If the entity is **remote** or **automated**, you can take control. To take control, select the **Control authority** button.
Green	Owner	You own control which enables to you to issue commands to the Robot. To release control, select the **Control authority** button.

The **User interaction mode** button indicates the current user interaction mode. Press it to switch between the modes.

8.2.5 How to put the Robot in autonomous control

The operator graphical user interface (GUI) can be used to put the Robot into autonomous mode.

To put the Robot into autonomous mode from the operator graphical user interface (GUI), follow these steps:

1. From the **Control Lease** panel, select **AUTO**.
   The **AUTO** button turns green.

> **Notice**
> When the Robot is in autonomous control, the following controls are not available in the operator GUI:
>
> - Robot control panel
>   - *For more information, see "3.2.5 Robot control panel" on page 82*
> - Spotlight control in the Sensor panel
>   - *For more information, see "3.2.4 Sensor panel" on page 80*

8.3 How to use the ANYbotics Workforce app

The Robot can be controlled and operated using the ANYbotics Workforce app. It is important that you are familiar with all the controls and features of the ANYbotics Workforce app before you operate the Robot.

Before using the ANYbotics Workforce app, ensure your tablet has:

- Orientation lock enabled.
- Sleep mode disabled.
- App set to full screen.

> **Notice**
> We recommend turning on the number row feature in the keyboard settings of your mobile device.

> **Notice**
> For field operation, we recommend using a hand strap to carry your tablet in one hand and using the pen in the other hand, especially if you have to wear gloves.

8.3.1 How to launch the ANYbotics Workforce app

To launch the ANYbotics Workforce app, follow these steps:

1. Turn on your tablet.
2. Turn on the Robot.

► *For more information, see "5.4 Start the Robot" on page 117*

3. Select the ANYbotics Workforce app icon from your tablet.
   The ANYbotics Workforce app launches.
4. Confirm that the connectivity status on the status bar of the app is green.
   The app is connected to the Robot and ready to work.

8.3.2 How to manage control of the Robot with the ANYbotics Workforce app

The ANYbotics Workforce app can be used to manage Robot control.

► *For more information, see "8.2 How to manage control of the Robot" on page 200*

The **Control authority** button on the top left of the status bar indicates the current control authority owner and acts as an interface to take or release control:

Color	State	Description
Black	Free	No entity owns control. To take control, select the **Control authority** button.
Yellow	Foreign	A foreign entity owns control. The entity is one of the following: • **On-site** • **Remote**: indicated with a tablet icon. • **Automated**: indicated with a robot icon. If the entity is **remote** or **automated**, you can take control. To take control, select the **Control authority** button.
Green	Owner	You own control which enables to you to issue commands to the Robot. To release control, select the **Control authority** button.

The **User interaction mode** button indicates the current user interaction mode. Press it to switch between the modes.

8.3.3 How to activate the protective stop using the ANYbotics Workforce app

> **Warning**
>
> Danger due to collapsing!
>
> When the protective stop is activated and the Robot is walking, the Robot will collapse.
>
> Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the protective stop is activated on stairs.

The protective stop is activated to safely stop the Robot while leaving all actuators and systems enabled.

The protective stop can be activated using the ANYbotics Workforce app.

- To activate the protective stop, from the status bar select the protective stop button.
- To deactivate the protective stop when it is activated, select the protective stop button again.

Figure 45 - Protective stop activated

Figure 46 - Protective stop deactivated

8.3.4 How to activate the cut power using the ANYbotics Workforce app

The cut power is part of the safety functions of the Robot.

Warning

Danger due to collapsing!

When the emergency stop or cut power is activated, the Robot collapses.

Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the emergency stop or cut power is activated on stairs.

When activating the emergency stop or cut power, stand clear and keep all limbs away from the Robot. After activating the emergency stop or cut power, the Robot collapses and there is a crushing hazard.

The cut power is used to bring the Robot to an immediate and complete stop in case of an emergency.

To activate or deactivate the cut power, use the **CUT POWER** slider at the bottom of the ANYbotics Workforce app screen.

- To activate the cut power, hold and drag the slider all the way to the **right**.
- To deactivate the cut power, hold and drag the slider all the way to the **left**.

Figure 47 - Cut power slider (cut power deactivated)

Figure 48 - Cut power slider (cut power activated)

8.3.5 How to change operational modes using the ANYbotics Workforce app

> **Warning**
>
> Risk of serious injury or death!
>
> The Robot operates in **Blind** mode in the following situations:
>
> - When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
> - When docking
> - When in the **crawl** motion state
>
> This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.
>
> This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.
>
> Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The operational mode panel is available from the Robot control menu. The panel contains tools to control the motion of the Robot and the inspection payload.

To change the Robot operational mode, follow these steps:

1. From the app main screen, select .

> **Notice**
>
> The button of the Robot control menu changes depending on the operational mode selected.

2. From the menu, select .
3. Select an available operational mode.
   ► *For more information, see "Robot operational modes" table below*

> **Notice**
>
> The Robot can dock only in the **AUTO** mode.

4. To activate the selected operational mode, select  .
   Wait until the mode icon turns to green.

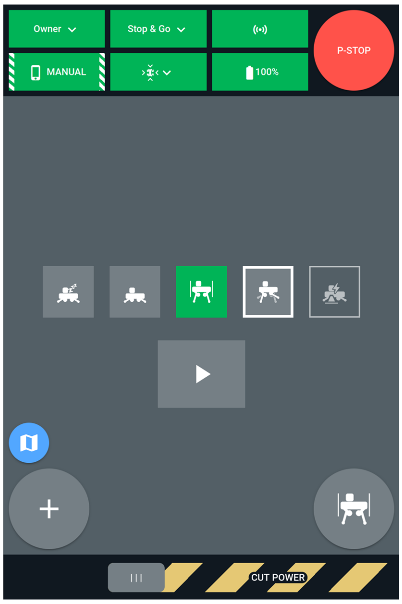
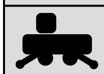
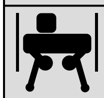


Figure 49 - Operational mode page

Table 35 - Robot operational modes

	**Sleep**	Makes the Robot lie down and disables the actuators. The danger zone active warning light is turned off.
	**Rest**	The Robot is commanded to lower its torso to the ground. The actuators are still active.
	**Stand**	The Robot is commanded to stand in its current location.
	**Walk**	The Robot is ready to walk.
	**Dock**	The Robot is commanded to find the nearest docking station and execute the docking procedure.

8.3.6 How to start a mission using the ANYbotics Workforce app

> **Caution**
>
> Risk of injury!
>
> When you select **Start Mission** in step 6, the Robot starts moving immediately.
>
> Before selecting **Start Mission**, ensure that it is safe for the Robot to perform the initial task.

You can control autonomous missions in the ANYbotics Workforce app using the mission player in the operator task menu.

To start a mission in the ANYbotics Workforce app, follow these steps:

1. Ensure the Robot is localized.
   - ▶ *For more information, see "8.3.13 How to localize the Robot" on page 224*
2. Ensure the Robot is in **AUTO** mode.
   - ▶ *For more information, see "8.3.2 How to manage control of the Robot with the ANYbotics Workforce app" on page 204*
3. From the app main screen, select .

> **Notice**
>
> The button of the Robot control menu changes depending on the operational mode selected.

The mission player opens.

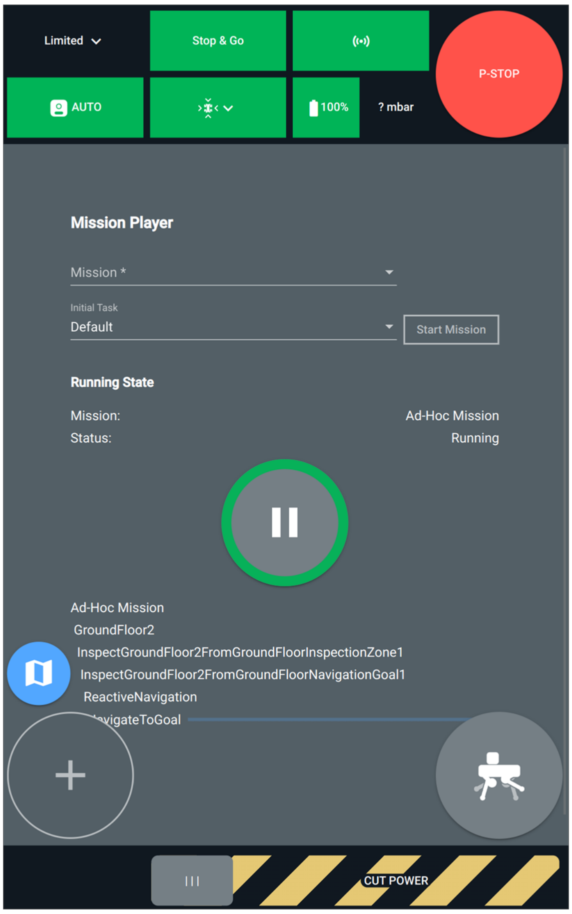


Figure 50 - Mission player

4. From the **Mission** drop-down, select the mission you want to run.

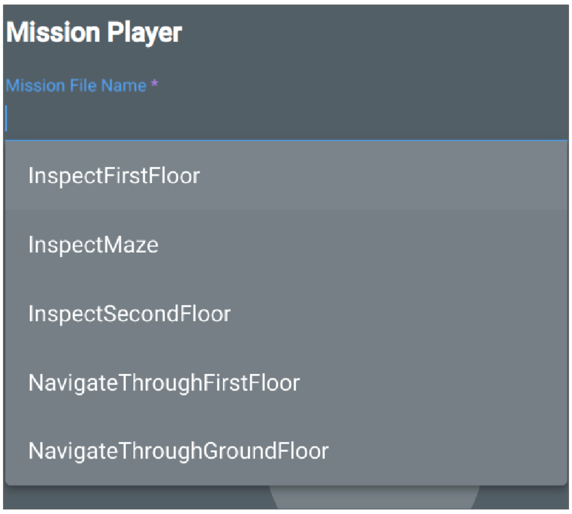


Figure 51 - Mission drop-down

5. From the **Initial Task** drop-down, select the task you want to start the mission:

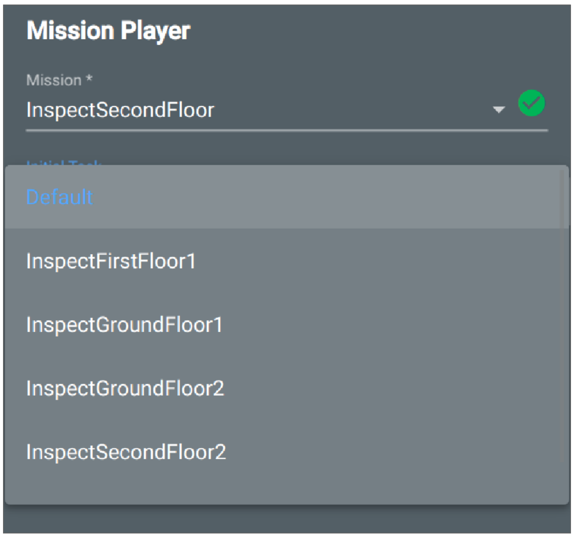


Figure 52 - Initial Task drop-down

The **Initial Task** drop-down displays the tasks in the mission in the order in which they will be performed.

- To start the first task then proceed through the tasks in sequence, select **Default**.
- To start the mission from a different task, select that task from the drop-down. When started, the mission starts from that task then proceed through the following tasks in sequence. The mission leaves out the tasks which come before the task you have selected in the sequence.

> **Tip**
>
> For example:
>
> Figure 52 shows that the mission InspectSecondFloor has the following tasks: InspectFirstFloor1, InspectGroundFloor1, InspectGroundFloor2, and InspectSecondFloor2.
>
> - To run the mission with all tasks, select **Default**.
>   The Robot will then perform InspectFirstFloor1, InspectGroundFloor1, InspectGroundFloor2, and InspectSecondFloor2 in that order.
> - To run the mission with only InspectGroundFloor1, InspectGroundFloor2, and InspectSecondFloor2, select InspectGroundFloor1 from the **Initial Task** drop-down.
>   The Robot will then perform InspectGroundFloor1, InspectGroundFloor2, and InspectSecondFloor2 only.

6. Select **Start Mission**.
   The Robot begins the initial task.

> **Notice**
>
> To pause the Robot while it is performing the mission, select the Pause button []. The pause button is displayed on all screens when the Robot is performing a mission.
>
> To resume the mission, select the Play button []. The play button is displayed on all screens when the Robot is paused while performing a mission.

> **Notice**
>
> You can monitor the Robot behavior using the **Running State** and **Task Progress**.

8.3.7 How to check the status of a task using the ANYbotics Workforce app

The ANYbotics Workforce app shows the navigation and inspection progress of a task in the mission player.

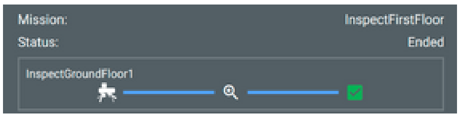
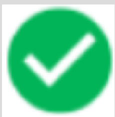


Figure 53 - Mission player showing the completed task status

The mission player shows an icon next to each task to indicate its status. The task status gives you information on the current status or outcome of the task.

Table 36 - Status icons in the mission player

	Shows the task was completed successfully.
	Shows the task was completed successfully, reading is normal.
	Shows the task result is an anomaly.

	Shows the task was unsuccessful.
	■ Shows the task didn't start. ■ Shows the task is in progress.
	Shows the task was skipped, for example, because the mission was paused.

8.3.8 How to run an ad-hoc mission

To inspect an object without programming a full mission, you can run an ad-hoc mission.

1. Select the object you want to inspect.

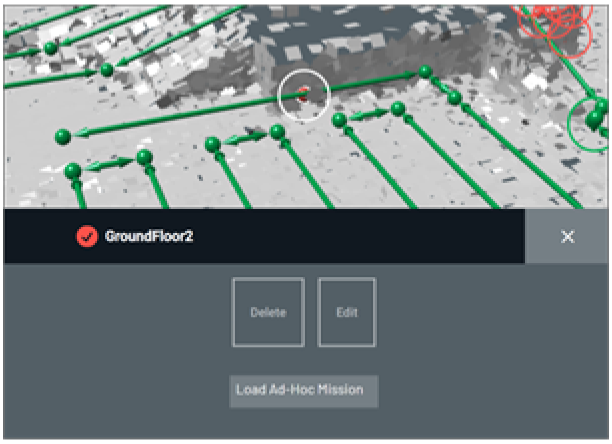


Figure 54 - Object overview

2. Select **Load Ad-Hoc mission**.
   A Play button is displayed.
3. Select the Play button.
   The Robot navigates to the object and performs an inspection.

Notice

When you load the ad-hoc mission, you can also control the ad-hoc mission from the mission player.

▶ *For more information, see "8.3.6 How to start a mission using the ANYbotics Workforce app" on page 209*

Notice

To pause the Robot while it is performing the mission, select the Pause button [ ]. The Pause button is displayed on all screens when the Robot is performing a mission.

To resume the mission, select the Play button [ ]. The Play button is displayed on all screens when the Robot is paused while performing a mission.

8.3.9 How to steer the Robot using the ANYbotics Workforce app

Caution

Always maintain visual contact with the Robot when steering it with the ANYbotics Workforce app.

You can steer the Robot using the steering control page of the ANYbotics Workforce app.

You can use one of the following steering modes:

- **Main steering**
  This mode gives you multi-directional control of the Robot. You can touch the screen and send velocity commands.
- **Transition steering**
  This mode allows you to perform more complex Robot steering with access to translation controls.

8.3.9.1 Main steering

To activate main steering, follow these steps:

1. From the app main screen, select .

Notice

The button of the Robot control menu changes depending on the operational mode selected.

2. Select .
3. Double tap the interactive zone to switch between steering modes.

Notice
When activated, the main steering mode changes the interactive zone color to gray.

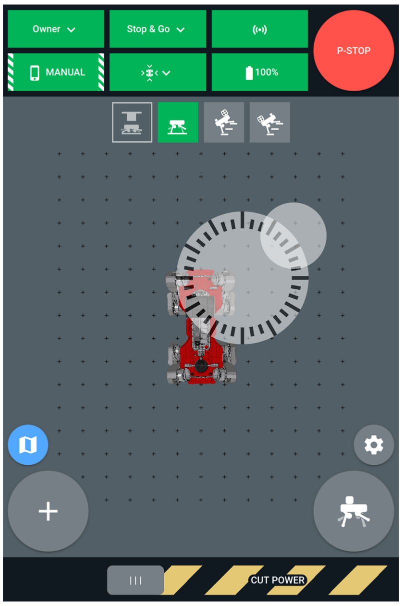


Figure 55 - Main steering mode

Once activated, you can touch the screen in the interactive zone and send commands to the Robot:

- Forward: slide upward (A in Figure 56).
- Backward: slide downward.
- Around the yaw axis: slide sideways (B in Figure 56).
- Turn while walking: slide diagonally (C in Figure 56).

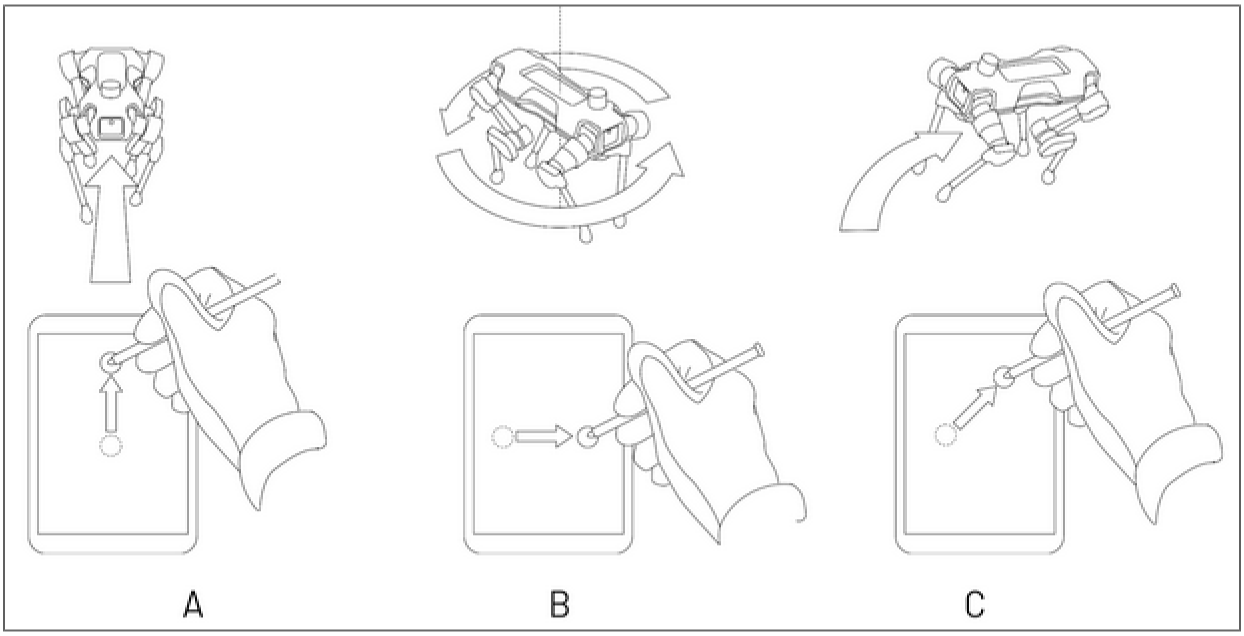


Figure 56 - Steering the Robot in the main mode

Notice

You can also use wide angle cameras to steer the Robot.

- To use the wide angle cameras, from the side panel, select .

The selected camera is indicated on the Robot top view in the screen.

Tip

Use the wide angle cameras when:

- The Robot is in narrow spaces.
- The safe distance of 2 m blocks the direct view of the Robot.

8.3.9.2 Transition steering

To activate transition steering, follow these steps:

1. From the app main screen, select .

> **Notice**
>
> The button of the Robot control menu changes depending on the operational mode selected.

2. Select .
3. Double tap the interactive zone to switch between steering modes.

> **Notice**
>
> When activated, the transition steering mode changes the interactive zone color to white.

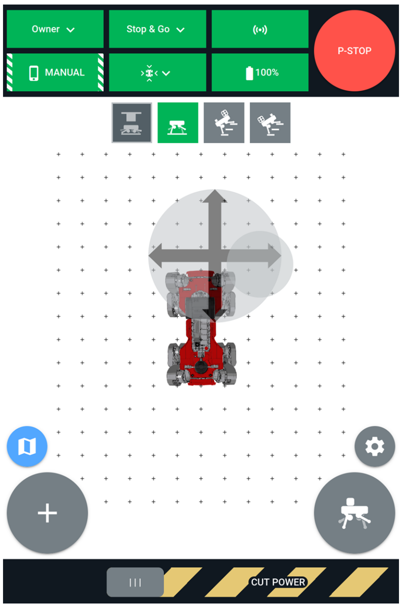


Figure 57 - Transition steering mode

Once activated, you can touch the screen in the interactive zone and send commands to the Robot:

- Forward: slide upward (A in Figure 58).
- Backward: slide downward.
- Strafe: slide sideways (B in Figure 58).
- Forward and to the side: slide diagonally (C in Figure 58).

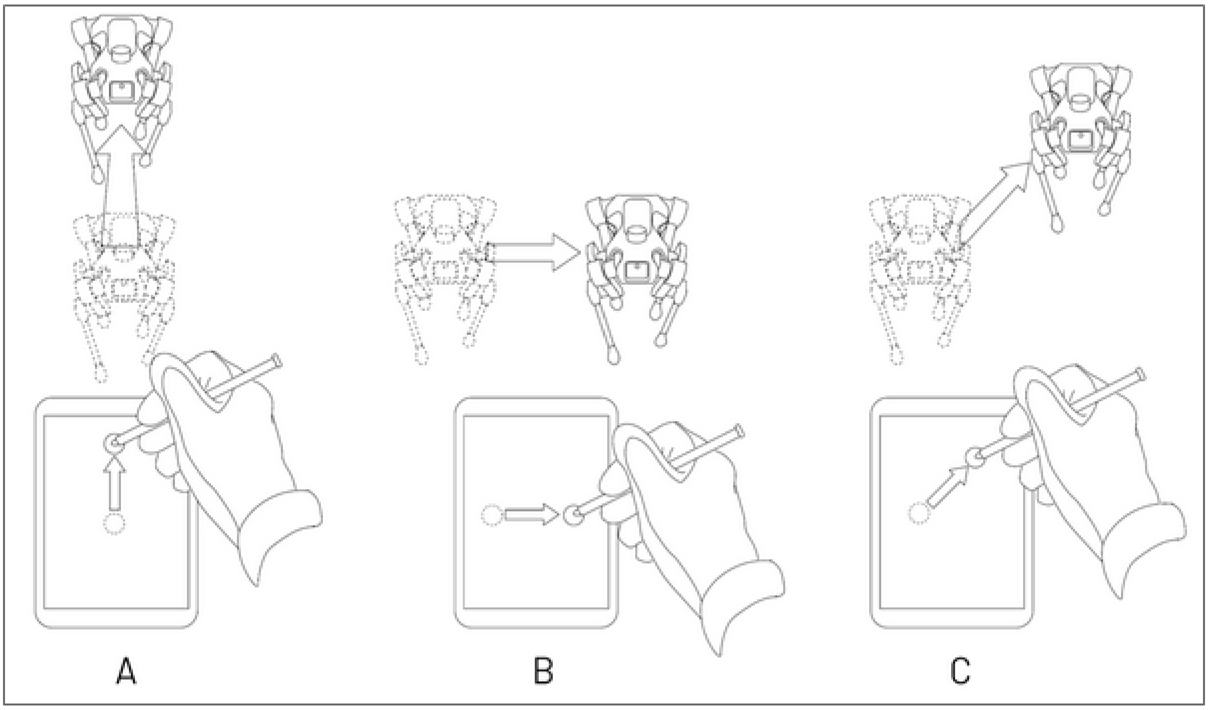


Figure 58 - Steering the Robot in the transition mode

8.3.10 How to steer the Robot on stairs using the ANYbotics Workforce app

Warning

Risk of serious injury or death!

The Robot may fall when using stairs.

- Do not stand below the Robot when the Robot is using stairs.
- Do not operate the Robot on stairs when people are on the stairs.
- Do not operate the Robot on stairs that are part of the plant or site evacuation routes.
- Do not approach stairs when the Robot is using them.

Warning

Risk of serious injury or death!

The Robot must be facing in the correct direction when walking up or down stairs.

- When walking up stairs, the front of the Robot must point to the top of the stairs.
- When walking down stairs, the rear of the Robot must point to the bottom of the stairs.

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Warning

- Do not stand underneath the Robot when it operates on an elevated platform or stairs.
- Do not try to catch or break the fall of the Robot, if the Robot collapses.

Caution

Risk of damage!

The Robot may fall if there is not enough power to use the stairs.

Ensure that the Robot has sufficient battery charge before attempting to use stairs or starting an autonomous mission which requires the Robot to use stairs.

Caution

Risk of damage!

The Robot may fall if it is stopped while using the stairs.

Do not stop the Robot while it is climbing stairs except in case of emergency.

Tip

ANYbotics recommends applying warning signs around your plant or site highlighting when the Robot uses a dedicated set of stairs on a regular basis.

You can move on stairs in two ways:

- With LIDAR unit pointing downward (the optimal way):
- With LIDAR unit pointing upward:

To activate stair climbing, follow these steps:

1. From the app main screen, select .

> **Notice**
> The button of the Robot control menu changes depending on the operational mode selected.

2. Select one of the stair climbing modes: / .
   A warning pop-up window opens.
3. Select **Confirm**.
   Wait until the mode icon turns to green.

> **Notice**
> When activated, the stair climbing mode changes the interactive zone color to blue.

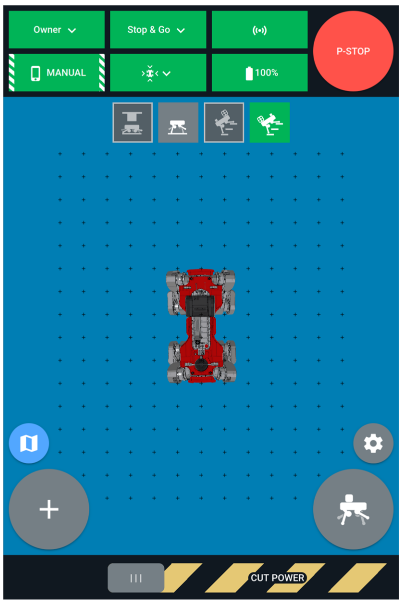


Figure 59 - Stair climbing mode

Once activated, you can touch the screen in the interactive zone and send commands to the Robot:

- Forward: slide upward (A in Figure 60).
- Backward: slide downward.
- Strafe: slide sideways (B in Figure 60).
- Forward and to the side: slide diagonally (C in Figure 60).

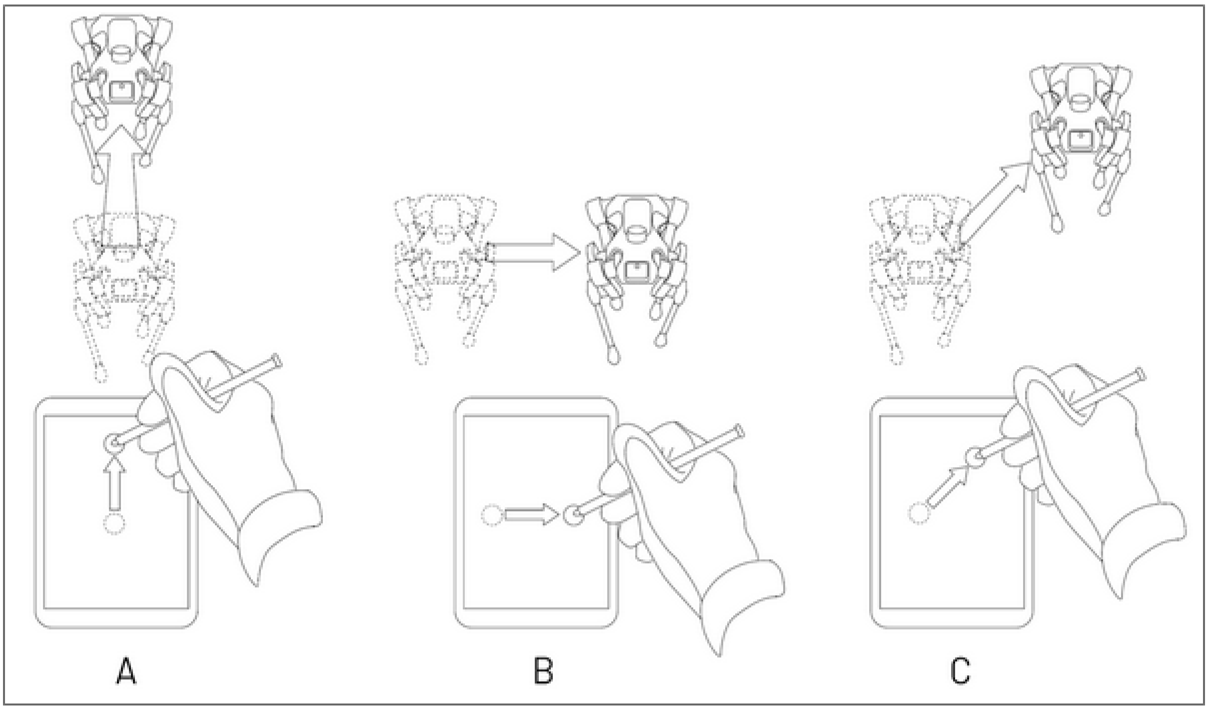


Figure 60 - Steering the Robot in the stair climbing mode

8.3.11 How to change collision avoidance behavior using the ANYbotics Workforce app

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The behavior of the Robot when an obstacle is encountered can be configured.

The collision avoidance behavior is controlled using the collision avoidance switch in the operator GUI or in the ANYbotics Workforce app.

Notice

Each time you change the collision avoidance behavior using the operator GUI or the ANYbotics Workforce app, it always overrides the previous setting.

If you change the collision avoidance setting in the ANYbotics Workforce app, the change will be reflected in the operator GUI collision avoidance switch.

▶ *For more information, see "8.5.20 How to change the collision avoidance behavior using the GUI" on page 250*

To change the collision avoidance behavior using the ANYbotics Workforce app, follow these steps:

1. Make sure the Robot is being controlled by the ANYbotics Workforce app.
   ▶ *For more information, see "1 How to view who is in control of the Robot" on page 1*
2. From the status bar, select a collision avoidance behavior.
   ▶ *For more information, see "Collision avoidance behaviors" table below*

Table 37 - Collision avoidance behaviors

Collision avoidance behavior	Robot behavior
Blind	The Robot does not respond to an obstacle or cliff.
Stop-and-go	The Robot stops when it encounters an obstacle or cliff and wait for corrective actions.

> **Notice**
>
> When the Robot is in autonomous mode, the collision avoidance switch only configures the default collision avoidance behavior. If the Robot crosses an edge which is configured with a different collision avoidance behavior, the Robot automatically switches to the new collision avoidance behavior.
>
> For example, if the Robot is in autonomous mode and the operator selects **Stop-and-go**, the Robot uses this collision avoidance behavior. However, if the Robot then crosses an edge configured with **Blind** mode, it switches to **Blind**.

8.3.12 How to control the inspection payload using the ANYbotics Workforce app

The inspection payload is mounted on a pan-tilt unit to allow it to be directed towards a point of interest during an inspection.

You can control the inspection payload using the ANYbotics Workforce app.

To control the inspection payload, follow these steps:

1. From the app main screen, select .

> **Notice**
>
> The button of the Robot control menu changes depending on the operational mode selected.

2. Select .

   When activated, you can touch the screen and send commands to the Robot:

   - The color camera is set by default. If the thermal camera is enabled and you want to switch back to color camera, select and .
   - To enable the thermal camera, used on the inspection payload, select and .

- To enable the microphone on the inspection payload, select and .
- To enable the LED feature on the inspection payload, select and .
- To pan or tilt the payload, touch and slide the interactive zone.
- To zoom and center the camera image, draw a square in the video feedback.
- To go back to default camera position, select **Reset Zoom**.
- To go back to default payload position, select **Reset Payload**.

You can also control the inspection payload using the Graphical User Interface (GUI).

► *For more information, see "8.5.9 How to control the inspection payload using the GUI" on page 239*

8.3.13 How to localize the Robot

You can localize your Robot using the ANYbotics Workforce app in two ways.

To localize the Robot on the basis of a place it visited, follow these steps:

1. Load a map.
2. Steer the robot to a place the Robot visited.
3. From the status bar, select > **Place Recognition**.

> **Notice**
>
> This method only works if the location is unique.
>
> You can see all such place in the Operator GUI.
>
> ► *For more information, see "9.5 Localization issues" on page 266*

To localize the Robot on the basis of its docking station, follow these steps:

1. Load a map.
2. Steer the robot to the Robot docking station.
3. From the status bar, select > **Dock Station**.

> **Notice**
>
> This method only works if the docking station location was recorded and the docking station wasn't moved.
>
> ► *For more information, see "6.9.5 Configure the docking station in the operation environment" on page 146*

8.4 How to configure waypoints

The Robot can navigate autonomously in the environment following a predefined set of waypoints.

The waypoints are a representation of the path the Robot can take within its environment. The waypoints are composed of a list of nodes and a list of edges connecting any two nodes.

For this computation it automatically connects the starting position and the goal position of the Robot to the nearest edge in the waypoints description.

8.4.1 How to use the motion states for waypoint edges

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The motion control module is responsible to command the Robot to move in a coordinated fashion while ensuring stability of the Robot. Motion states can be configured per edge in the waypoints to fine-tune the Robot's locomotion for a given environment.

The following motion states can be set for a waypoints edge:

- **blind_walk**
- **crawl**
- **perceptive_walk**
- **stair_climbing_lidar_up**
- **stair_climbing_lidar_down**

To access and edit the motion states, follow these steps:

1. On the operator graphical user interface (GUI), select
2. Select **Waypoints Editor** to open the **Waypoints Editor** panel.
3. Select the path edge(s) that require the **motion states** to be changed.

   Use Shift+select to select multiple paths.

4. Expand the width of the **Waypoints Editor**.
5. Select the required **motion state**.

8.4.1.1 Available motion states

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

Table 38 - List of motion states

Motion state	Description	Limitations
blind_walk	The Robot walks with a trotting gait, blindly. This is the default motion state.	■ This is a blind controller. It is intended for locomotion over slightly rough terrain and has no direct perception of the terrain. ■ While the controller can safely go down minor steps and drops (up to 200 mm), ANYbotics does not recommend use of this controller for stairs.
crawl	The Robot walks with a trotting gait with its torso close to the ground. This enables the Robot to crawl under suspended objects.	■ This motion state is intended for use on smooth terrain with a roughness of less than ±50 mm.
fallen	Fall recovery is triggered when this motion state is selected or the Robot has detected a fall.	

Motion state	Description	Limitations
perceptive_ walk	The Robot walks with a trotting gait.	■ The Robot can traverse simple obstacles and steps less than 250 mm and 30° incline, using perception. ■ When using this motion state, do not walk the Robot towards negative obstacles, below floor level. For example, do not operate the Robot near gaps in the floor or unprotected edges.
rest	The Robot lies down on the ground and takes a rest position.	■ Avoid any pushes to the Robot, as the Robot will not try to recover balance by stepping. ■ This motion state should only be used for smooth surfaces (±50 mm roughness), with up to 30° incline.
run	The Robot can achieve 1.3 m/s on relatively flat terrain (grass, brick roads and concrete). It is a blind mode.	■ This motion state is still in development. Use with caution. ■ Running in rough terrain can lead to the Robot falling over. ■ This motion state cannot be used with navigation.

Motion state	Description	Limitations
square_up	The Robot moves its legs into a symmetrical configuration.	■ Avoid any pushes to the Robot, as the Robot will not try to recover balance by stepping. ■ This motion state should only be used for smooth surfaces (±50 mm roughness), with up to 30° incline.

<table>
<tr><th>Motion state</th><th>Description</th><th>Limitations</th></tr>
<tr><td>stair_ climbing_ lidar_up or stair_ climbing_ lidar_down</td><td>The Robot can traverse industrial stairs compliant with ISO standards perceptively.</td><td>
This motion state should only be used by trained operators.
▶ For more information, see "1.15 Stairs" on page 45
Warning
Risk of serious injury or death!
The Robot must be facing in the correct direction when walking up or down stairs.
When walking up stairs, the front of the Robot must point to the top of the stairs.
When walking down stairs, the rear of the Robot must point to the bottom of the stairs.
Caution
Risk of damage!
The Robot may fall if it is stopped while using the stairs.
Do not stop the Robot while it is climbing stairs except in case of emergency.

Notice
When the Robot is in the stair_ climbing_lidar_up or stair_ climbing_lidar_down motion state, it can only use the Blind path follower mode.
The Robot cannot turn while it is on stairs.
The Robot cannot avoid obstacles while on stairs.
You cannot pause the Robot while the Robot
</td></tr>
</table>

Motion state	Description	Limitations
		is on the stairs. To stop the Robot when it is climbing stairs, use the **P-stop** or **CUT POWER** buttons in the GUI. Only do this in case of an emergency. ■ Do not change controllers while the Robot is on stairs. ■ The Robot can climb stairs with an incline of up to 45°, a step height of less than 230 mm and a minimum run of 210 mm. ■ The stairs must be at least 800 mm in width to provide safe clearance while the Robot climbs the stairs. ■ Use **stair_climbing_lidar_up** for climbing the stairs with LIDAR unit pointing upward. ■ Use **stair_climbing_lidar_down** for climbing the stairs with LIDAR unit pointing downward.
torso_control	The Robot stands in place and allows the Operator to control its torso height and orientation.	■ Avoid any pushes to the Robot, as the Robot will not try to recover balance by stepping.

8.4.2 How to use the path follower modes

Use the **Waypoints Editor** to change the path following mode of the Robot.

To change the path follower mode, follow these steps:

1. On the operator graphical user interface (GUI), select
2. Select **Waypoints Editor** to open the **Waypoints Editor** panel.
3. Select the path edge(s) that require the **path follower mode** to be changed.
   Use Shift+select to select multiple paths.
4. Expand the width of the **Waypoints Editor**.
5. Select the required **path follower mode**.

> **Notice**
> When the Robot is in the stair_climbing_lidar_up or stair_climbing_lidar_down motion state, it can only use the Blind **path follower mode**.

► *For more information, see "8.3.11 How to change collision avoidance behavior using the ANYbotics Workforce app" on page 222*

Table 39 - List of path follower modes

Mode	Description
Blind	Blindly follows the path without considering obstacles.
Stop-and-go	Stops in front of obstacles that obstruct the Robot path and waits until they move away before continuing to navigate.
Default	Uses the configured collision avoidance behavior. ▶ *For more information, see "8.5.20 How to change the collision avoidance behavior using the GUI" on page 250* ▶ *For more information, see "8.3.11 How to change collision avoidance behavior using the ANYbotics Workforce app" on page 222*

8.4.3 How to configure path follower parameters for edges

To configure path follower parameters for edges:

1. Select ☰.
2. Select **Waypoints Editor**.
   The Waypoints Editor opens.
3. Select an edge.
4. From **path follower parameters**, select **Edit**.
   The **Path Follower Parameters** window opens.
5. To add a parameter, select **+**.
   To remove a parameter, select the parameter and select **x**.
6. From the drop down list in the **Name** column, select a parameter.
7. In the **Value** column, enter a value for the parameter.
8. Select **Save**.

Notice

The **stop_go_behavior_timeout** parameter specifies the time that the Robot will stop for in front of an obstacle before triggering a failure.

The value of the parameter is given in seconds. The parameter only works in the **Stop-and-go** mode.

▶ *For more information, see "8.4.2 How to use the path follower modes" on page 230*

Notice

Currently, the **Waypoints Editor** only supports the **stop_go_behavior_timeout** parameter.

More parameters will be added to the drop-down list in the future.

8.5 How to operate the Robot from the GUI

The Robot can be controlled and operated using the operator GUI. It is important that you are familiar with all the controls and features of the operator GUI before you operate the Robot.

8.5.1 How to activate the protective stop using the operator GUI

Warning

Danger due to collapsing!

When the protective stop is activated and the Robot is walking, the Robot will collapse.

Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the protective stop is activated on stairs.

The protective stop is activated to safely stop the Robot while leaving all actuators and systems enabled.

The protective stop can be activated using the operator GUI.

- To activate the protective stop, from the operator GUI, select P-STOP .
- To deactivate the protective stop when it is activated, from the operator GUI, select P-STOP again.

8.5.2 How to stop the Robot using the GUI cut power

The GUI cut power is part of the safety functions of the Robot. The GUI cut power slider can be activated to stop the Robot in an emergency.

▶ *For more information, see "1.5.2 GUI cut power" on page 22*

Warning

Danger due to collapsing!

When the GUI cut power is activated, the Robot collapses.

Depending on the work environment, this may cause injury to anyone in the vicinity and damage the Robot. For example, if the GUI cut power is activated on stairs.

When engaging the GUI cut power, stand clear and keep all limbs away from the Robot. After engaging the GUI cut power, the Robot collapses and there is a crushing hazard.

Notice

The GUI cut power is implemented and tested carefully but does not comply with ISO EN 13849-1.

To activate the GUI cut power slider:

1. From the operator GUI, select and hold →.
2. Drag → over the **CUT POWER** text and release.

   The text changes from **CUT POWER** to **RELEASE**.

To deactivate the GUI cut power slider:

1. From the operator GUI, select and hold ←.
2. Drag ← over the **RELEASE** text and release.

   The text changes from **RELEASE** to **CUT POWER**.

8.5.3 How to localize the Robot in a map

The Robot can localize itself in an existing map.

To localize the Robot using an existing map, follow these steps:

1. From the **Robot status panel**, select .

   The **Localization and Mapping** panel opens.
2. From the **Step 1: Workflow** tab, select **Use an existing map**.

   The system will launch a semi-automated sequence where you will be prompted for input if needed.
3. In the **Load map** box, enter the path to the existing map.
4. Select **Load**.

   A symbol will appear next to **Load**:

  - ✓: indicates the map has loaded successfully
  - ✕: indicates the map has not loaded successfully

5. From the **Step 3: Initial guess** tab, check if automatic place recognition has calculated an initial location guess correctly.
   - ▶ *For more information, see "9.9 Place recognition issues" on page 267*
6. Check that the virtual Robot is in the same position in the **3D Visualization** as the physical Robot in the real world.
7. Select **Done** to close the **Localization and Mapping** panel.

▶ *For more information, see "9.5 Localization issues" on page 266*

8.5.4 How to display sensor data

As the Robot performs its mission you can view the sensor data from the operator graphical user interface (GUI).

Use the **Sensor** panel to select and view sensor data, for example, zoom camera controls.

▶ *For more information, see "3.2.4 Sensor panel" on page 80*

8.5.5 How to navigate to a pose

Using the operator graphical user interface (GUI) you can command the Robot to navigate to a desired pose.

There are two ways to navigate to a pose using the operator GUI:

- Move the interaction marker to the desired pose. Right-click on the interaction marker and select **Go Here (Straight Line)** or **Go Here (Along Waypoints)**.
  - ▶ *For more information, see "3.2.7.1 Interaction marker" on page 84*
- Right-click on a navigation goal you want to navigate to and select **-> Go Here.**

To pause navigation, from the **Mission panel**, select .

8.5.6 How to start a mission using the GUI

Caution

You should always check the state of localization before starting a mission. If the localization is poor, then the Robot might not work as intended.

Caution

Risk of damage!

The Robot may fall if it is stopped while using the stairs.

Do not stop the Robot while it is climbing stairs except in case of emergency.

You can control autonomous missions in the Graphical User Interface.

To start a mission using the GUI, follow these steps:

1. On the **Mission** panel, from the dropdown menu, select a mission.
   This action loads the mission. The contained tasks are shown in the list of tasks, and the 3D visualization shows a preview of the Robot path.
2. Check that the tasks match your expectations for the mission.
3. If you want to change the default mission settings, you can do the following:
   - By default, the mission is started from the beginning of the first task. If you want to start the mission from another task, open the settings of the corresponding task and enable **Start From This Task**.
     This action updates the preview of the mission.
   - By default, the mission is previewed assuming that all tasks succeed. If you want to preview what happens if a task completes with a different outcome, open the settings of the task and enable the alternative outcome in the **Preview Mission For Outcome ...** dropdown menu.
     This action updates the preview of the mission. It does not affect the actual execution of the mission.
4. To start the mission, press **Play**.
   Once started, the button turns into a **Pause** button.

Tip

If the Robot is not climbing stairs, you can pause the mission at any time by pressing the **Pause** button. You cannot pause the Robot while the Robot is climbing stairs.

To stop the Robot when it is climbing stairs, use the **P-stop** or **CUT POWER** buttons in the GUI or in the ANYbotics Workforce app. Do not stop the Robot while it is climbing stairs except in case of emergency.

In the case of a critical event, the Robot pauses the mission automatically and reacts accordingly. Depending on the type of event, the Robot gives you a selection of choices by sending a notification. During the time the Robot is reacting on an event, the button turns into a **Stop** button. By pressing it, you can interrupt the reaction at any time.

8.5.7 How to steer the Robot using the GUI Joypad

You can steer the Robot using the GUI joypad in the ANYmal software.

To control the GUI joypad, you have to take control of the Robot using the GUI.

▶ *For more information, see "8.2.3 How to manage control of the Robot using the GUI" on page 202*

8.5.7.1 Steering when standing

To steer the Robot posture with the GUI when the Robot stands, follow these steps:

1. From the **Robot status** panel, select .
   The **Robot** window opens.
2. Select the **Operational Modes** tab.
   The current operational mode is highlighted in green.
   The selected operational mode is highlighted with a white border.
   ▶ *For more information, see "Robot operational modes" table below*
3. Select .
   The operational mode changes to the new operational mode and is highlighted in green.

> **Notice**
>
> If an error occurs,  and an error message are displayed.

The Robot operational mode can be changed if the Robot is still executing an operational mode.

For example, if the Robot was executing the **Dock** operational mode, the mode can be changed to **Stand**.

4. From the **Robot Control** panel, select the **Joypad** icon.
   ▶ *For more information, see "3.2.5 Robot control panel" on page 82*

   - Use the left **Robot joypad** to control the pitch and roll of the Robot.
   - Use the right **Robot joypad** to control the height and yaw of the Robot.

8.5.7.2 Steering when moving

To control the Robot with the GUI when the Robot moves, follow these steps:

1. From the **Robot status** panel, select .

   The **Robot** window opens.
2. Select the **Operational Modes** tab.

   The current operational mode is highlighted in green.
   The selected operational mode is highlighted with a white border.

   ▶ *For more information, see "Robot operational modes" table below*
3. Select .

   The operational mode changes to the new operational mode and is highlighted in green.

> **Notice**
>
> If an error occurs,  and an error message are displayed.

The Robot operational mode can be changed if the Robot is still executing an operational mode.

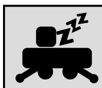
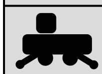
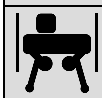
For example, if the Robot was executing the **Dock** operational mode, the mode can be changed to **Stand**.

4. From the **Robot Control** panel, select the **Joypad** icon.

   ▶ *For more information, see "3.2.5 Robot control panel" on page 82*

- Use the left **Robot joypad** to move the Robot forward, back, and sideways.
- Use the right **Robot joypad** to rotate the Robot.

Table 40 - Robot operational modes

	**Sleep**	Makes the Robot lie down and disables the actuators. The danger zone active warning light is turned off.
	**Rest**	The Robot is commanded to lower its torso to the ground. The actuators are still active.
	**Stand**	The Robot is commanded to stand in its current location.
	**Walk**	The Robot is ready to walk.
	**Dock**	The Robot is commanded to find the nearest docking station and execute the docking procedure.

8.5.8 How to change the operational modes using the GUI

> **Warning**
>
> Risk of serious injury or death!
>
> The Robot operates in **Blind** mode in the following situations:
>
> - When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
> - When docking
> - When in the **crawl** motion state
>
> This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.
>
> This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.
>
> Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

To change the Robot operational mode, follow these steps:

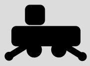
1. From the **Robot status** panel, select .
   The **Robot** window opens.
2. Select the **Operational Modes** tab.
   The current operational mode is highlighted in green.
   The selected operational mode is highlighted with a white border.
   ▶ *For more information, see "Robot operational modes" table below*
3. Select .
   The operational mode changes to the new operational mode and is highlighted in green.

> **Notice**
>
> If an error occurs,  and an error message are displayed.

The Robot operational mode can be changed if the Robot is still executing an operational mode.

For example, if the Robot was executing the **Dock** operational mode, the mode can be changed to **Stand**.

Table 41 - Robot operational modes

	**Sleep**	Makes the Robot lie down and disables the actuators. The danger zone active warning light is turned off.
	**Rest**	The Robot is commanded to lower its torso to the ground. The actuators are still active.
	**Stand**	The Robot is commanded to stand in its current location.
	**Walk**	The Robot is ready to walk.
	**Dock**	The Robot is commanded to find the nearest docking station and execute the docking procedure.

8.5.9 How to control the inspection payload using the GUI

The inspection payload is mounted on a pan-tilt unit to allow it to be directed towards a point of interest during an inspection.

The operator graphical user interface (GUI) provides a payload joypad and zoom camera to control the inspection payload.

To control the inspection payload using the joypad, follow these steps:

1. Take control authority.
2. Set the user interaction mode to **MANUAL**.
3. On the **Robot Control** panel, select the payload joypad icon.
   ▶ *For more information, see "3.2.5 Robot control panel" on page 82*
4. On the payload joypad, do one of the following:

   - Select any of the nine pre-defined positions to specify the pan and tilt of the inspection payload.
   - Drag the positional cross to any location on the payload joypad to specify your own pan and tilt of the inspection payload.

   The selected position is shown as a white box with a cross inside. The current position is identified by a grey box with a cross inside. You can see the inspection payload move, in the **3D visualization** window, to the position you select.

To control the inspection payload using the zoom camera, follow these steps:

1. On the **Sensor** panel, select the zoom camera icon.
   ▶ *For more information, see "3.2.4 Sensor panel" on page 80*
2. In the zoom camera window, draw a frame to center and zoom into the region of interest.
   The selected frame shows as a red box in the zoom camera window.

In the **3D visualization** window, you can see the inspection payload move to the position you select.

You can also control the inspection payload using the ANYbotics Workforce app.

- *For more information, see "8.3.12 How to control the inspection payload using the ANYbotics Workforce app" on page 223*

8.5.10 How to monitor gas concentrations using the gas sensing payload

If the gas sensing payload is mounted on the Robot, the Robot can continuously measure the concentration of different types of gases in an environment.

The 3D Visualization Panel displays the level of gas per 0.25 m^2 as colored spheres, as shown in Figure 61:

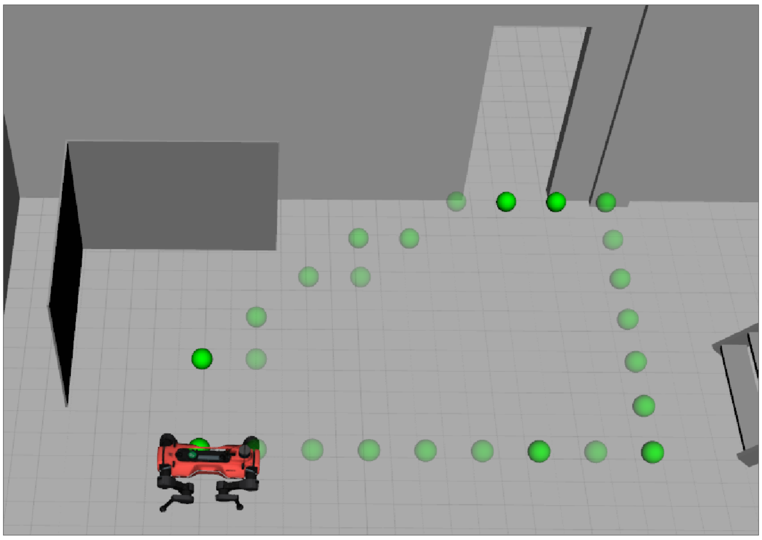


Figure 61 - 3D Visualization Panel displaying gas concentration

> **Notice**
> The thresholds for each detection level depend on the specific sensor mounted on the Robot.

The color of the sphere indicates the concentration of gas:

Color	Gas concentration per 0.25 m^2
Green	Low
Orange	Medium
Red	High

The opacity of the sphere indicates the confidence of the measurement:

- A semi-transparent sphere represents a measurement with low confidence.
- An opaque sphere represents a measurement with high confidence.

Tip

To increase the confidence of a measurement, allow the robot to remain in the same position for a few seconds.

To view the history of a measurement and its confidence levels over time, select or hover over the sphere.

When gas concentration exceeds a preset level of concentration, a notification is displayed.

Notice

The notifications are displayed based on raw measurements, and not on aggregated measurements of the sensor.

You can configure the gas detection thresholds in the Robot configuration file on the LPC at ***/home/integration/.ros/config.yaml***:

```
combustible_gas_measurement_aggregator:
 aggregation:
  interpretation:
    high_concentration_threshold: 6.0 # [mA]
    mid_concentration_threshold: 5.0 # [mA]
    notification_concentration_threshold: 6.0 # [mA]
```

Notice

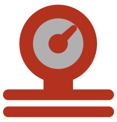
The accuracy of gas reading depends on technological and environmental factors.

For more information, refer to the datasheet of the sensor's manufacturer.

8.5.11 How to manually inspect points of interest

A point of interest can be one of the three types.

Table 42 - Point of interest inspection types

Icon	Inspection type	Inspection options
	Simple	■ **Take Picture** ■ **Take Picture From Here** ■ **Record Audio Sample** ■ **Record Audio Sample From Here**
	Dial	■ **Read Dial** ■ **Read Dial From Here** ■ **Read Object** ■ **Read Object From Here**
	Thermal	■ **Analyze Temperature** ■ **Analyze Temperature From Here**
	Gas	■ **Measure Concentration** ■ **Measure Concentration from Here**
	Static Video Recording	■ **Record Static Video** ■ **Record Static Video From Here**

A point of interest can be inspected by the Robot in the following ways:

- From the current Robot location
- By moving the Robot to the point of interest

To inspect a point of interest from the current Robot location, follow these steps:

1. From the **3D Visualization** panel in the operator GUI, right-click a point of interest.
2. Select the inspection option labelled **... From Here**.

For example, to take a picture, select **Take Picture From Here**.
The Robot will attempt to inspect the point of interest from it's current location.

To move the Robot to a point of interest for inspection, follow these steps:

1. From the **3D Visualization** panel in the operator GUI, right-click a point of interest.
2. Select an inspection option.

   For example, to take a picture, select **Take Picture**.
   The Robot will move to the point of interest to inspect it.

8.5.12 How to check for warnings

When you are using the Robot you can check for warning and error messages by using the operator graphical user interface (GUI).

To check for warning and error messages, follow these steps:

1. From the **Robot status** panel, select .

   The **Robot** window opens.
2. Select the **Diagnostics** tab.
3. On the left of the window, select **Warnings** or **Errors**.

   The list of messages expands to show all messages of the selected type.
4. Select any message in the list to see the full message in the right of the window.

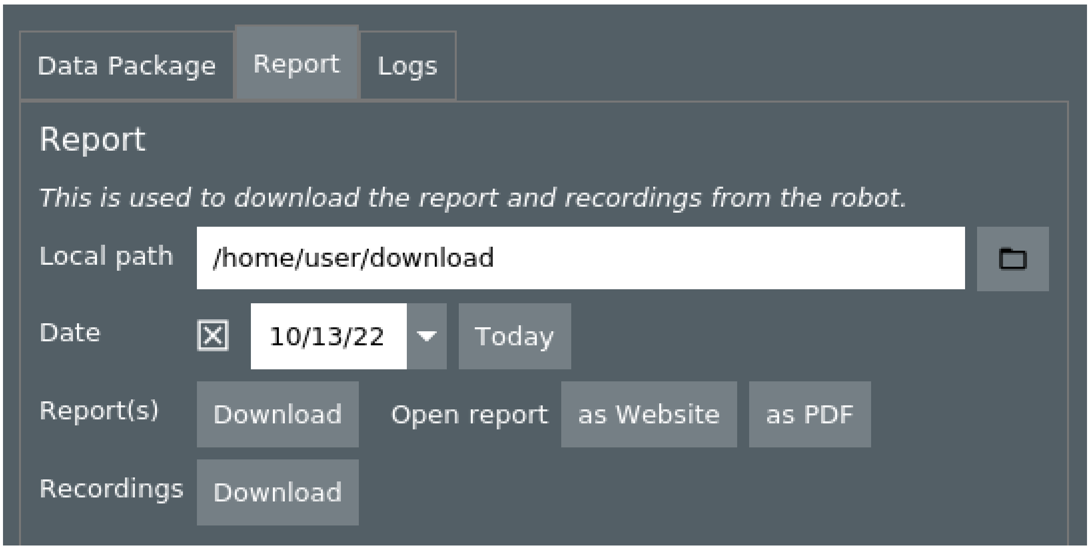
8.5.13 How to get a mission report

After a mission, use the **Data Sync** system to download a collected data report from the Robot to your computer.

To download a report, follow these steps:

1. From the data management panel, open the **Data Sync** panel.
2. Enter the address of the data synchronization server.

   This can be one of the following:
   - an ad-hoc server, for example, `ads.local:58050`
   - a server in your local network, for example, `data-sync.organization.com:58050`.
3. Select **Login**.
4. Select the Robot you require data from.
5. Select **Connect**.
6. Select the **Report** tab.



7. Select the file icon next to the **Local path** and navigate to the location where you want to download your report to.
8. Select **Choose**.
9. To download the report for a specific date, select the **Date** check box and use the drop-down to choose a date.

   Alternatively, if you want to download reports for all dates, leave the **Date** check box unselected.
10. Select **Download** next to reports or **Download** next to recordings.

The data is downloaded to your specified location. If you have downloaded the report for a specific date, you can open the report as a website in a browser or as a PDF.

8.5.14 How to get logs with ANYmal data sync (ADS)

To get detailed logs of the Robot for customer support, use the ANYmal Data Sync (ADS) to download log files from the Robot to your computer.

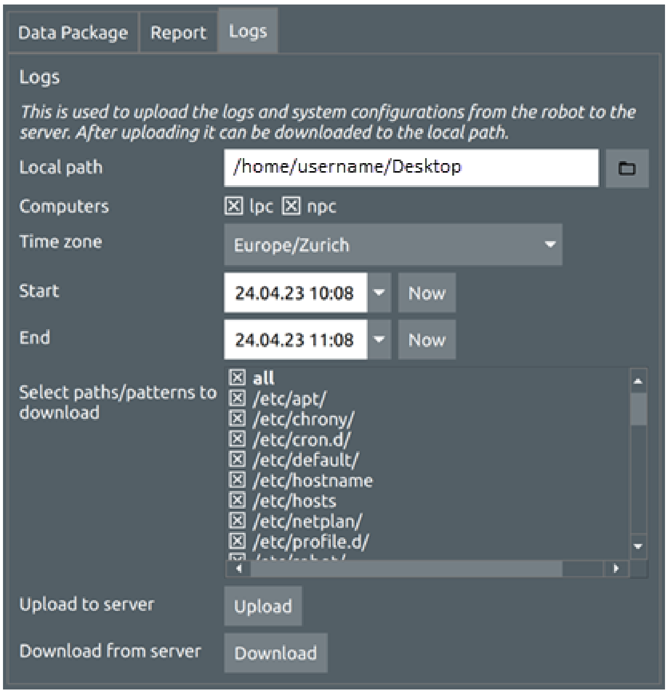
> **Notice**
>
> If you use an ad-hoc data sync sever, start the server first.
>
> ▶ *For more information, see "6.3.1 Start an ad-hoc data sync server" on page 124*

To get the logs, follow these steps:

1. From the data management panel, open the **Data Sync** panel.
2. Enter the address of the data synchronization server.

   This can be one of the following:
   - an ad-hoc server, for example, `ads.local:58050`
   - a server in your local network, for example, `data-sync.organization.com:58050`.

3. Select **Login**.
4. Select the Robot you require data from.
5. Select **Connect**.
6. Select the **Logs** tab.



7. Select the file icon next to the **Local path** and navigate to the location where you want to download your logs to.
8. Specify the start and end times in which you would like to download log files.
9. Select the logs you want to download.

> **Notice**
> Files and folders starting with `.` are hidden by default. You need to enable displaying hidden files in your system to select them for download.

10. You can now do one of the following:
    - Select **Upload** to upload the logs to the Data Sync Server.
    - Select **Download** to download the logs to the local path.

    The logs are available in your specified location.

8.5.15 How to dock and undock the Robot using Environment objects

> **Warning**
>
> Risk of serious injury or death!
>
> The Robot operates in **Blind** mode in the following situations:
>
> - When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
> - When docking
> - When in the **crawl** motion state
>
> This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.
>
> This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.
>
> Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

To dock/undock the Robot using Environment objects:

1. From the Robot status panel, select **Localization**.
   The **Localization** window will appear.
2. In the **Localization** window, ensure the **Localization** option is selected.
3. From the map, select **Docking station** > **Dock** or **Undock**.
   The Robot will start the docking/undocking procedure.

8.5.16 How to dock and undock the Robot using operational modes

> **Warning**
>
> Risk of serious injury or death!
>
> The Robot operates in **Blind** mode in the following situations:
>
> - When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
> - When docking
> - When in the **crawl** motion state
>
> This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.
>
> This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.
>
> Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

To dock/undock the Robot using operational modes:

1. From the **Robot status** panel, select .
   The **Robot** window opens.
2. Select the **Operational Modes** tab.
   The current operational mode is highlighted in green.
   The selected operational mode is highlighted with a white border.
   ▶ *For more information, see "Robot operational modes" table below*
3. Select .
   The operational mode changes to the new operational mode and is highlighted in green.

> **Notice**
>
> If an error occurs,  and an error message are displayed.

The Robot operational mode can be changed if the Robot is still executing an operational mode.

For example, if the Robot was executing the **Dock** operational mode, the mode can be changed to **Stand**.

Table 43 - Robot operational modes

	Sleep	Makes the Robot lie down and disables the actuators. The danger zone active warning light is turned off.
	Rest	The Robot is commanded to lower its torso to the ground. The actuators are still active.
	Stand	The Robot is commanded to stand in its current location.
	Walk	The Robot is ready to walk.
	Dock	The Robot is commanded to find the nearest docking station and execute the docking procedure.

8.5.17 How to dock the Robot without localization

Warning

Risk of serious injury or death!

The Robot operates in **Blind** mode in the following situations:

- When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
- When docking
- When in the **crawl** motion state

This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.

This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.

Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The Robot can dock without localization. In this case, the docking station needs to be visible by the Robot sensors.

To dock the Robot without localisation:

1. From the Robot status panel, select .

   The **Localization and Mapping** window opens.
2. Make sure the **Localization** option is not selected.
3. Using the **Operational Modes** tool, dock the Robot.

▶ *For more information, see "8.5.16 How to dock and undock the Robot using operational modes" on page 247*

8.5.18 How to avoid obstacles with global replanning

You can enable a global replanning recovery behavior to make the Robot avoid obstacles. This recovery behavior replans an alternative path along the waypoints avoiding obstacles detected by the Robot.

> **Notice**
>
> The global replanning is only supported for the Stop-and-go mode.
>
> The Robot stops in front of an obstacle until the Stop-and-go timeout of 20 seconds expires and then the Robot triggers global replanning.

To enable the global replanning recovery behavior, follow these steps:

1. Take control authority.
2. Set the user interaction mode to **MANUAL**.
3. From the **Robot status** panel, select **Surrounding**.
   The **Navigation** window opens.
4. From the **Recovery Behaviors** section, select the **Global Replanning** check box.

> **Tip**
>
> To disable the feature, deselect the **Global Replanning** check box.

8.5.19 How to plan a path

You can use the interaction marker in the operator graphical user interface (GUI) to plan a path.

> **Notice**
>
> This feature plans a path from the Robot position to the interaction marker and visualizes it in the operator graphical user interface (GUI).
>
> It does not command the Robot to follow the planned path.
>
> ▶ *For more information, see "8.5.6 How to start a mission using the GUI" on page 235*

To plan a path, follow these steps:

1. In the operator graphical user interface (GUI), drag the interaction marker to a desired location.
2. Right-click on the interaction marker.

You can choose between two path planning options:

- **Plan path to here (Straight Line)**: you plan a straight line path from the current Robot position to the interaction marker.
- **Plan path to here (Along Waypoints)**: you plan a path from the current Robot position to the interaction marker following defined waypoints.

▶ *For more information, see "8.4 How to configure waypoints" on page 225*

8.5.20 How to change the collision avoidance behavior using the GUI

> **Warning**
>
> Risk of serious injury or death!
>
> The Robot operates in **Blind** mode in the following situations:
>
> - When walking up or down stairs using the **stair_climbing_lidar_up** or **stair_climbing_lidar_down** motion states
> - When docking
> - When in the **crawl** motion state
>
> This means the Robot will not detect obstacles with its sensors and will collide with obstacles in its path.
>
> This is regardless of the collision avoidance behavior selected using the operator GUI or the ANYbotics Workforce app.
>
> Keep all people and objects out of the path of the Robot when the Robot is in the **stair_climbing_lidar_up**, **stair_climbing_lidar_down**, or **crawl** motion states.

The behavior of the Robot when an obstacle is encountered can be configured.

The collision avoidance behavior is controlled using the collision avoidance switch in the operator GUI or in the ANYbotics Workforce app.

> **Notice**
>
> Each time you change the collision avoidance behavior using the operator GUI or the ANYbotics Workforce app, it always overrides the previous setting.
>
> If you change the collision avoidance setting in the ANYbotics Workforce app, the change will be reflected in the operator GUI collision avoidance switch.

▶ *For more information, see "8.3.11 How to change collision avoidance behavior using the ANYbotics Workforce app" on page 222*

To change the collision avoidance behavior using the GUI, follow these steps:

1. Take control authority.
2. Set the user interaction mode to **MANUAL**.

3. From the drop-down menu of the switch, select a collision avoidance behavior.
   - ▶ *For more information, see "Collision avoidance behaviors" table below*

Table 44 - Collision avoidance behaviors

Collision avoidance behavior	Robot behavior
Blind	The Robot does not respond to an obstacle or cliff.
Stop-and-go	The Robot stops when it encounters an obstacle or cliff and wait for corrective actions.

Notice

When the Robot is in autonomous mode, the collision avoidance switch only configures the default collision avoidance behavior. If the Robot crosses an edge which is configured with a different collision avoidance behavior, the Robot automatically switches to the new collision avoidance behavior.

For example, if the Robot is in autonomous mode and the operator selects **Stop-and-go**, the Robot uses this collision avoidance behavior. However, if the Robot then crosses an edge configured with **Blind** mode, it switches to **Blind**.

8.5.21 How to navigate in straight narrow passages with the Stop-and-go mode

A straight narrow passage or straight narrow corridor is a straight narrow path between two solid, straight walls.

The Robot can walk forward along the narrow passage but cannot turn in place. When navigating straight narrow passages in **Stop-and-go** mode, the Robot may collide with the wall but will stop in front of obstacles present inside the narrow passage, including Operators.

▶ *For more information, see "8.4.2 How to use the path follower modes" on page 230*

The recommended minimum width of a narrow passage is 70 cm.

Warning

When navigating in narrow passages, the Robot is likely to collide with the walls.

Only use the **Stop-and-go** mode if there are solid vertical walls on either side of the passageway and there is no risk of the Robot falling down.

For example, do not use this feature when the Robot is climbing along a walkway with railings on either side.

Notice

You can navigate the Robot in narrow passages less than 70 cm wide, however this carries the following risks:

- The Robot may get stuck when trying to getting inside.
- The Robot may collide with the walls more frequently.

8.5.21.1 How to configure waypoints

Position one waypoint at each end of the narrow passage.

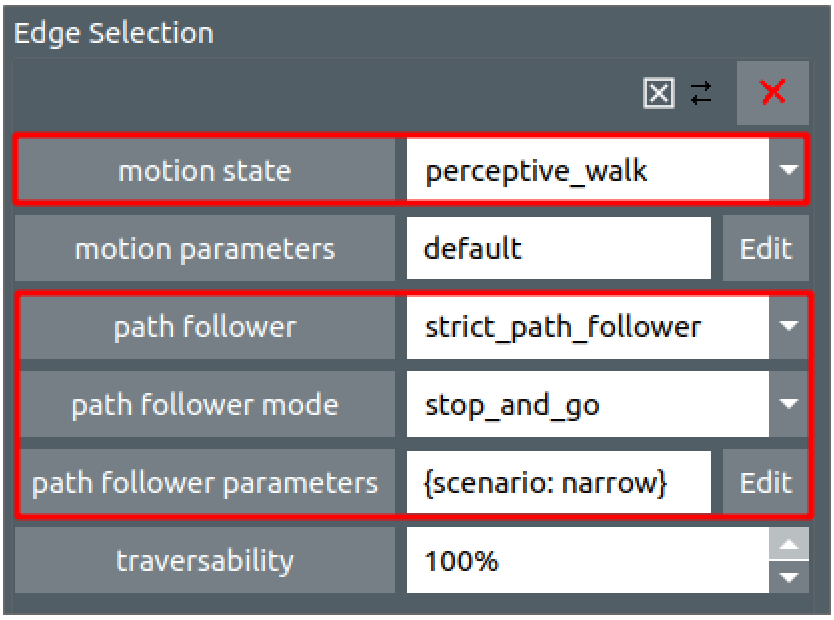
- Position the waypoints at least 100 cm away from the entrance of passage.
- Align the waypoints so that the edge that connects them goes through the middle of the narrow passage and runs parallel to the walls.

8.5.21.2 How to configure edges

Perform the following steps for all edges inside narrow passages:

1. Select .
2. Select **Waypoints Editor**.
   The Waypoints Editor opens.
3. Select the edge inside the narrow passage.
4. For **motion state**, select **perceptive_walk**.
5. For **path follower**, select **strict_path_follower**.
6. For **path follower mode**, select **stop_and_go**.
7. For **path follower parameters**, select **Edit** and configure the parameter as follows:
   - Name: select **scenario**
   - Value: select **narrow**

   Save the parameter configuration.
8. Check the edge parameters are configured as in the following image:



8.5.22 How to enable Robot location algorithms in the simulation

By default, the location, mapping, and state estimation algorithms are disabled in the simulation due to computational reasons.

You can enable these algorithms in the simulation, for example, to train Operators in a realistic scenario.

To enable the algorithms:

1. Start the ANYmal software launcher applsication on your computer.
2. Select **Simulation**.
3. Select to find all installed Robot configurations on your computer.
4. From the **Robot** dropdown, select the desired configuration.
   D stands for the ANYmal (gen. D).
5. Select **Feature Toggles**.
   The **Set Feature Toggles** window opens.
6. Set **Slam** and **State estimation** feature toggles to **real**.
7. To save the setting, select **OK**.
   The **Set Feature Toggles** window closes.
8. Select **Start**.
   You now control the Robot in the simulation.

8.5.23 How to use ANYmal API in the simulation

You can use the ANYmal API on the operator computer running the simulation.

Tip

For ease of use, we recommend running the Software Development Kit (SDK) with the simulation.

To use the SDK in the simulation, follow these steps:

1. Start the ANYmal software launcher application on your computer.
2. Select **Simulation**.
3. Select to find all installed Robot configurations on your computer.
4. From the **Robot** dropdown, select the desired configuration.
   D stands for the ANYmal (gen. D).
5. Select **Feature Toggles**.
   The **Set Feature Toggles** window opens.
6. Set **Data synchronization** feature toggle to **local-testing**.
7. To save the setting, select **OK**.
   The **Set Feature Toggles** window closes.
8. Select **Start**.
   You now control the Robot in the simulation.
9. Run the SDK by connecting to `http://localhost:11314` and setting the credentials directory to `/none`.
   For example, to use the `mission_example` SDK, run the following command:

```
rosrun anymal_sdk_python_example mission_example -s
http://localhost:11314 --credentials-dir /none
```

8.5.24 How to configure the Robot in the simulation

You can configure the Robot to appear in a different location when the simulation starts.

Notice

If the simulation started, you can make the Robot appear in a different location by selecting **Tools/Robot Respawner** in the 3D visualization.

Create a ***.yaml*** configuration file using the following syntax:

- To make the Robot appear with a different leg configuration:

```
gazebo:
  joint_states:
    leg_config: xx
```

For `leg_config`, enter:

  - `xx` to make the Robot appear standing, or
  - `rest` to make the Robot appear lying.
- To make the Robot appear in a different location:

```
spawn_anymal:
  init_pose:
    x: 0.0
    y: 0.0
    z: 0.8
    R: 0.0
    P: 0.0
    Y: 0.0
```

Where `init_pose` is the initial pose of the main body.

When you start the simulation, specify the configuration file in the command line interface:

```
rosrun anymal_d sim.py --extension-config-file
</path/to/your/file.yaml>
```

8.5.25 How to use the sensors in the simulation

You can use the sensors of the Robot in the simulation.

Visual cameras

The zoom camera and the wide angle cameras see the feed specified for your Robot.

The cameras perceive the `visual` representation specified in your model files.

▶ *For more information, see "6.4.3 File content" on page 127*

Thermal camera

The thermal camera sees the red channel of the emissive RGB material values of an objects visual representation specified for your Robot. A red value of `1.0` (resp. 255) is matched to the maximum temperature and a red value of `0.0` (resp. 0) corresponds to the minimum temperature. Every value in between is linearly interpolated. If the blue or green value is not zero, the object is seen by the camera as having ambient temperature (22 °C).

Notice

The temperature range is between 25 and 550 °C. This means a red value of `0` is 25 °C, and a value of `1` is 550 °C.

The following example snippet sets the detectable temperature to 70% of the thermal camera's range.

It needs to be added to the `<visual>` tag of your Robot.

```
<material>
```

```
  <ambient>0 0 0 1</ambient>
  <diffuse>0 1 0 1</diffuse>
  <specular>0 0 0 0</specular>
  <emissive>0.7 0 0 1</emissive>
</material>
```

▶ *For more information, see "6.4.3 File content" on page 127*

Microphone

The microphone outputs the contents of a given audio file in an endless loop as measurement. You can configure the audio file by setting the ROS parameter ***/audio/capture_audio/source*** to the full path to the audio file.

You can specify the audio file in the ***.yaml*** extension configuration:

```
audio:
  capture_audio:
    source: /path/to/audio/file
```

Gas sensors

You can change the measurement which the gas sensors output by calling the ROS service:

```
rosservice call /yoctopuce/sensor/set_state "{sensor_id: 0, is_
enabled: true, value: 0.0, unit: ''}"
```

Depth sensors

The LIDAR and the depth cameras see the collision representation specified for your Robot for a collision part associated to them.

The depth sensors only see objects that have the `<collision>` tag. The collision tag specifies the location and size of a simple geometric object.

▶ *For more information, see "6.4.3 File content" on page 127*

8.6 How to attach customer payloads

Customers can attach a payload to the Robot using the mechanical interface and external sensors using the connector ports.

> **Warning**
>
> Risk of serious injury or death!
>
> The customer payload must not make the Robot unsafe.
>
> - Do not prevent access to the Robot emergency stop.
>   - ▶ *For more information, see "1.5.1 Robot emergency stop" on page 21*
> - Do not cover the Robot heat sinksor fans.
>   - ▶ *For more information, see "2.3.10 Heat sinks and fans" on page 61*
> - Make sure the customer payload does not make the Robot unstable or likely to fall. To discuss your requirements before attaching a customer payload, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

8.6.1 How to attach a customer payload to the mechanical interface

A customer payload can be attached to the Robot using the mechanical interface.

> **Warning**
>
> Risk of serious injury or death!
>
> The customer payload must not affect the Robot operation.
>
> - Make sure the customer payload does not touch the Robot legs during operation.
>   - ▶ *For more information, see "2.3.11 Legs" on page 62*
> - Make sure the customer payload does not touch the inspection payload during operation.
>   - ▶ *For more information, see "2.3.21 Inspection payload" on page 72*
> - Make sure the customer payload is protected from fall damage.
> - Secure all cables on the customer payload to prevent them catching moving parts.
> - Make sure the customer payload does not make the Robot unstable or likely to fall. To discuss your requirements before attaching a customer payload, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

The mechanical interface uses M4 screws at two depths. The correct torque must be used when tightening screws. The use of Loctite™ 243 on screw threads is recommenced when attaching a customer payload.

Table 45 - Mechanical interface screw sizes and torque specifications

Screw size	Depth	Torque
M4	4.4 mm	1.1 Nm
M4	8.0 mm	2.3 Nm

The size of the mechanical interface and the number of attachment points depends on the configuration of the inspection payload.

The following figures show the areas available for a customer payload highlighted in green. Areas which must not be obstructed with a customer payload are highlighted in orange.

- Inspection payload fitted to the Robot (Figure 62).
- No payload fitted to the Robot (Figure 63).

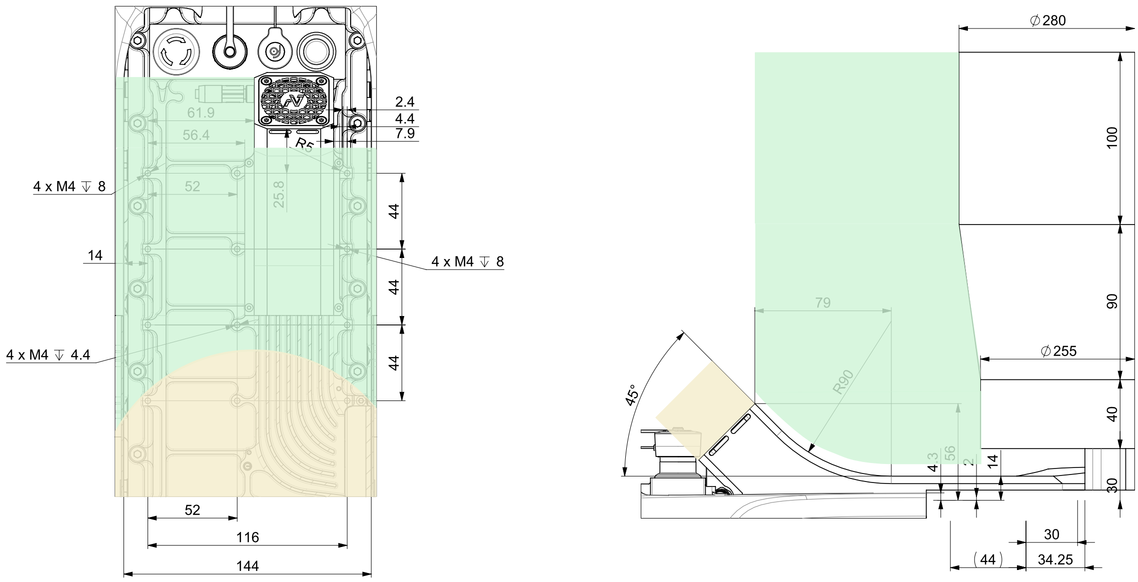


Figure 62 - Mechanical interface with inspection payload fitted to the Robot

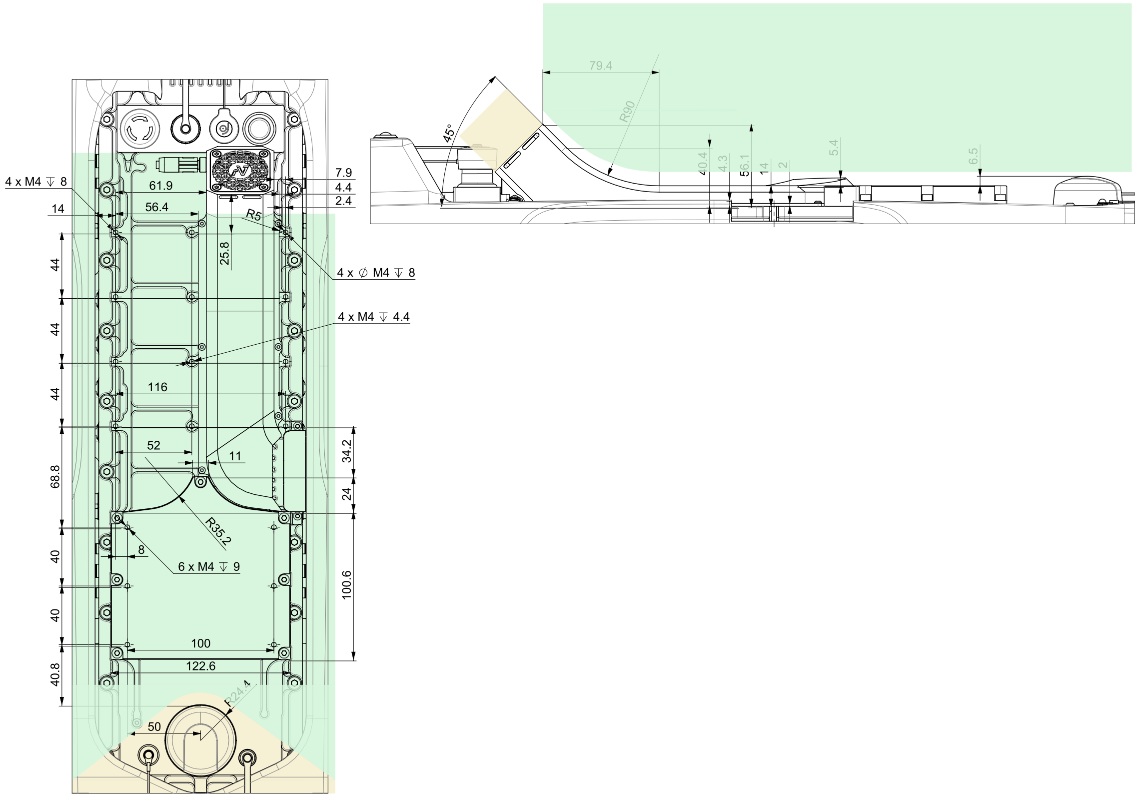
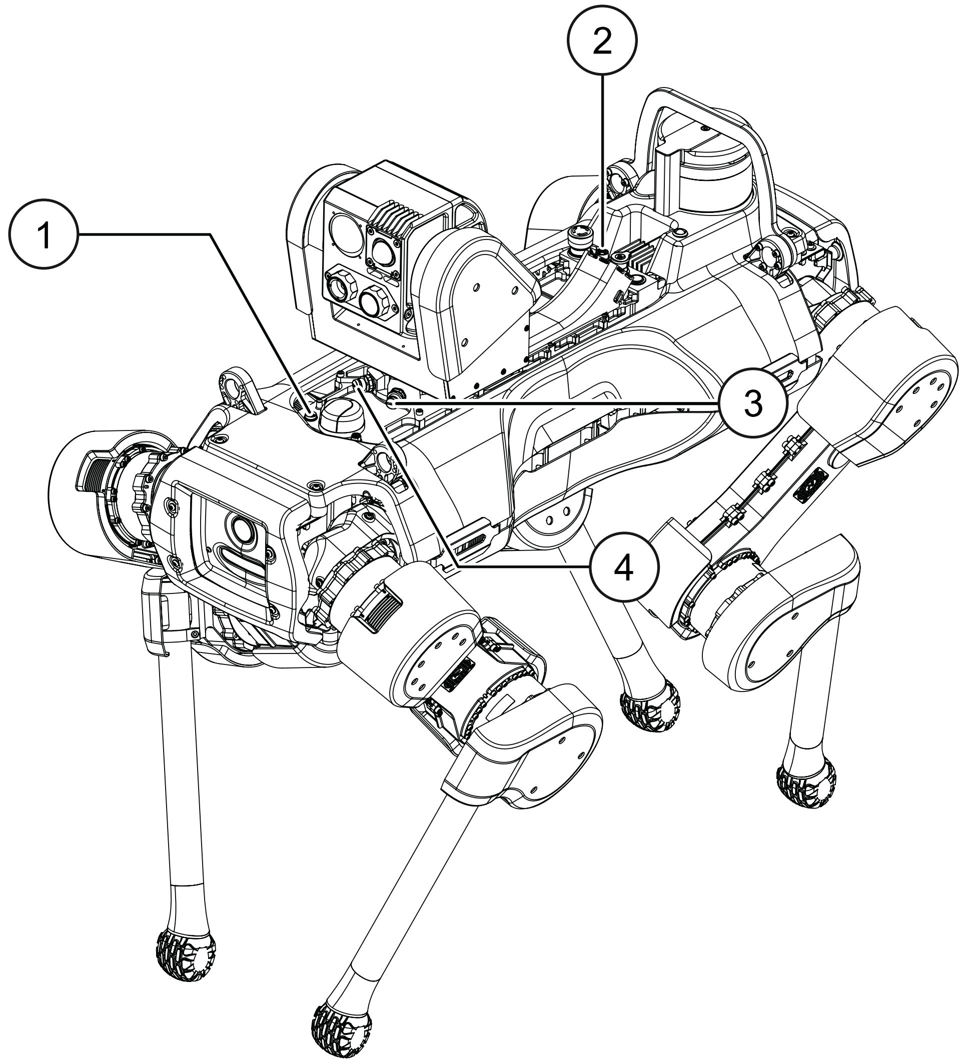


Figure 63 - Mechanical interface with no payload fitted to the Robot

8.6.2 How to attach external sensors to the connector ports

External sensors can be attached to the Robot using four connector ports.



1	USB type-C port	▶	*For more information, see "12.16.2 USB Type-C port" on page 314*
2	Ethernet port	▶	*For more information, see "12.16.1 Ethernet port" on page 313*
3	RS-485 port	▶	*For more information, see "12.16.4 RS-485 port" on page 318*
4	RS-232 port	▶	*For more information, see "12.16.3 RS-232 port" on page 316*

Figure 64 - Connector ports on the Robot

> **Notice**
> Do not supply power to the Robot through any connector ports.
> The power current must not be more than the specification for the connector port.
> ▶ *For more information, see "12.16 Pin-outs of connectors" on page 312*

> **Notice**
> Use of the ethernet connector port is at the owner's risk.

8.7 How to transport the Robot

To safely transport the Robot and batteries to another location, you must do the following:

- Robot:
  - Pack the Robot, and all related equipment, into the Transport Box.
    - ▶ *For more information, see "2.3.20 Transport Box " on page 72*
  - Any equipment that cannot be packed into the Transport Box must be transported separately using suitable packaging methods.
- Batteries:
  - Remove battery from the Robot.
  - The batteries state of charge must be between 20% and 30% (IATA guidelines).
  - Robot battery valve plug must be opened one turn.
    - ▶ *For more information, see "4.2 Insert the Robot battery" on page 103*
  - Batteries must be transported following local battery handling regulations.
    - ▶ *For more information, see "1.12 Battery" on page 41*
- After the transportation, immediately make sure that the batteries are properly stored.
  - ▶ *For more information, see "10.5.2 Store the battery" on page 295*

9 TROUBLESHOOTING

This section provides troubleshooting information for the Robot.

9.1 Actuators overheat

Warning

- Do not stand underneath the Robot when it operates on an elevated platform or stairs.
- Do not try to catch or break the fall of the Robot, if the Robot collapses.

Caution

- Do not attempt to restart the Robot until overheated actuators have cooled.
- Do not use water or ice spray to cool an overheated actuator.

The actuators generate heat and are actively cooled by the Robot. The actuators can overheat in certain conditions, like:

- Hot ambient temperatures.
- Clogged cooling fans.

To prevent damage to the actuators, the actuators disable themselves if their temperature gets too high. This leads to the Robot collapsing.

► *For more information, see "1.14 Lifting the Robot" on page 44*

Notice

The GUI or ANYbotics Workforce app shows the `Actuator Overtemperature Warning`.

The Operator has 20 seconds before the actuator turns off.

The Operator should take action to cool the actuators, for example, by:

- Stopping the Robot.
- Laying the Robot down.

In the case of an overheated actuator, follow this procedure:

1. Ensure the Robot is in a safe area to lie down.
2. Engage the Robot **Protective Stop**.
3. Disable all actuators.

> **Notice**
>
> Do not shut down the Robot.
>
> This ensures that fans stay running to cool the Robot components.

4. Wait until the actuators have cooled and there are no temperature warnings in the GUI.
   You can observe the actuator temperature and state in the **State Overview** panel or the **Actuators** tab of the operator graphical user interface (GUI).
5. After the actuators have cooled down, you can enable the actuators again and resume operation.

9.2 Create a detailed recording

If you encounter a problem and you want to record more information to send to ANYbotics for investigation, you can record data using ANYmal Record.

To make a recording with ANYmal Record, do the following:

1. From the GUI menu, select ▤ ***> ANYmal Record***.
2. Select the right **Output Preset** for the data you want to record:
   - **Navigation**
   - **Perception**
3. Optionally, enter an **Output Prefix** to make it easier to find the recording later.
4. Select **Start Recording**.

> **Tip**
>
> The recordings quickly become very large.

5. When you have finished, select **Stop Recording**.
6. Make a note of the filepath in **recording to:**. This is where the recording is saved.

9.3 Disk usage too high

The warning in the **Diagnostics** tab shows the disk usage is too high.

▶ *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

The Robot software stores different data on the disk, for example, inspection results. To avoid problems with disk space, the Robot software automatically deletes old files.

> **Notice**
> Log files are kept for a minimum of 1 day, report files for a minimum of 7 days.
> If storage space is available, reports are given priority and stored for over 60 days and log files up to 7 days.

Check for any large files, for example, video recordings or point clouds, and delete them.

If this does not help, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.4 Limited communication over Robot operating system

One or more of the following symptoms may indicate limited communication over the Robot operating system (ROS):

- You cannot switch motion states using the graphical user interface.
- You cannot take control authority.
- You can take control authority but it is lost after acquiring it.
- You give commands using the Graphical User Interface but the commands do not have an effect on the specified systems.
- The operator computer cannot receive some ROS messages.

Limited communication over the ROS can be caused by the following:

- Unclear network bond
- ▶ *For more information, see "9.4.2 Unclear network bond" on page 265*
- Strict network firewalls
- ▶ *For more information, see "9.4.1 Strict network firewall" on page 264*

9.4.1 Strict network firewall

A strict network firewall can severely limit message-passing capabilities, which makes ROS duplex communications unreliable.

You may need to change the firewall configuration of the operator computer.

To do this, run the following commands:

1. Backup existing firewall configuration:

```
$ sudo iptables-save > ~/iptables_backup.txt
```

2. Flush existing firewall rules:

```
$ sudo iptables -F
```

```
$ sudo iptables -X
$ sudo iptables -Z
```

3. Add new firewall rules:

```
$ sudo iptables -P INPUT ACCEPT
$ sudo iptables -P OUTPUT ACCEPT
$ sudo iptables -P FORWARD ACCEPT
```

> **Notice**
>
> Some Linux applications can change firewall rules without informing the user.
>
> If the firewall configuration was changed, you may need to redo the firewall rules starting from step 1 above.

> **Notice**
>
> Limited ROS communication may also be caused by an unclear network bond.
>
> If the above solution doesn't help, you may need to restart the Robot.
>
> ▶ *For more information, see "9.4.2 Unclear network bond" on page 265*

9.4.2 Unclear network bond

An unclear network bond occurs when an Operator does the following:

1. Connects to the robot through a network interface, for example ethernet.
2. Launches the GUI.
3. Disconnects from the currently active network interface.
4. Attempts to connect through another interface, for example a wireless connection.

Doing this breaks network bonds between the ROS hosts and introduces ambiguity in name resolution, which affects the ROS communication protocol.

To avoid an unclear network bond, restart the Robot after you switch interfaces.

▶ *For more information, see "4.5 Shut down the system" on page 107*

▶ *For more information, see "5.4 Start the Robot" on page 117*

> **Notice**
>
> To avoid an unclear network bond, do not switch network interface using the operator computer.

> **Notice**
>
> Limited ROS communication may also be caused by a strict network firewall.
>
> If the above solution doesn't help, you may need to change the firewall configuration of the operator computer.
>
> ▶ *For more information, see "9.4.1 Strict network firewall" on page 264*

9.5 Localization issues

ANYmal localization systems can reliably estimate the Robot position and orientation in many scenarios. However, there are some challenging environments to localize the Robot. There are three main types of challenging environments:

- Large indoor or outdoor environments where the Robot is not able to see far enough in one or more directions. For example, long corridors and open fields.
- Indoor or outdoor environments with objects moving around the Robot, obscuring point cloud sensors. For example, crowded convention halls.
- Indoor environments with highly reflective surfaces. The deflection of light on reflective surfaces makes point cloud sensors capture ambiguous information about the environment. For example, mirrors or glass windows.

In challenging environments, ANYmal localization systems require careful operation to obtain optimal results. The following practices are recommended:

- While walking behind or around the Robot, stay at least 3 meters away from the Robot.
- Reduce the Robot walking speed to allow it to capture more data with each step.
- Make the Robot move its base while standing in place to capture more details from its surroundings.

9.6 Network usage too high for onboard computers

The warning in the **Diagnostics** tab shows the network usage on the locomotion computer (LPC) and/or navigation computer (NPC) is too high.

▶ *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

The Robot software should not overuse the LAN connections between the onboard computers.

Check for any custom software running on your system and close it.

If this does not help, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.7 Network usage too high for the operator computer

The warning in the **Diagnostics** tab shows the network usage on the operator computer (OPC) is too high.

▶ *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

If the Wi-Fi connection usage is too high, the Graphical User Interface (GUI) becomes unresponsive.

Reduce the distance between the Robot and the router. Reduce the network usage by disabling large ROS topics in the 3D Visualization panel.

▶ *For more information, see "3.2.7 3D Visualization panel" on page 83*

If this does not help, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.8 Operator GUI cannot be started

The operator GUI cannot be started and shows the following error message in the console: `ANYmal OPC is already running. Exiting.`

This can happen if the operator GUI previously did not shut down properly.

To reopen the operator GUI:

1. Open a terminal session.
2. Connect to the locomotion computer using SSH:

```
ssh integration@anymal-<anymal-name>-lpc
```

> **Tip**
> Replace `<anymal-name>` with the name of your Robot.

3. Run the following command:

```
rosnode cleanup
```

4. From the software launcher, select **OPC**.

9.9 Place recognition issues

If automatic place recognition fails, try one of the following:

1. Move the Robot near a global localization descriptor.

    a. Move the Robot so its position roughly matches the position of a global localization descriptor, represented by a blue cube, in the **3D Visualization**.

b. Select **Try Place Recognition** to try and compute an initial guess from this viewpoint.

2. Move the **Interaction marker** near to the physical Robot position.

   a. From the **3D Visualization** panel, select and hold the blue ring of **Interaction marker**.
   b. Drag the **Interaction marker** and release on the map where the Robot is located in the real world.
   c. The Robot position and the orientation in the **3D Visualization** must be close to reality.
   d. Select and hold on the **Interaction marker** blue arrows to adjust the Robot height.
   e. The Robot height in the **3D Visualization** must be close to reality.
   f. Right-click on the **Interaction marker** and select **Set localization initial guess**.

3. Use streaming point cloud data to move the **Interaction marker**.

   a. From the **3D Visualization** panel, right-click on the **Interaction Marker** and select **Toggle publish point cloud**.
      LIDAR point cloud data is streamed from the position of the **Interaction Marker**.
   b. Select and hold the blue ring of **Interaction marker**.
   c. Drag the **Interaction marker** and match the LIDAR point cloud data with the world model or Localization and Mapping map in the **3D Visualization**.
   d. Right-click on the **Interaction marker** and select **Set localization initial guess**.

9.10 Processor or memory usage too high

The warning in the **Diagnostics** tab shows the processor or memory usage is too high.

► *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

The Robot software should not overuse the processor or memory.

Check for any custom software running on your system and close it.

If this does not help, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.11 Recover a router

If one of the following happens, you need to boot your router in failsafe mode:

- You cannot access the router using Ethernet or WiFi.
- You lost or need to reset the router password.
- The router often loses connection.

In the failsafe mode, you can:

- Access the router using an Ethernet cable.
- Format the configure and user files.
- Reconfigure the router.

To enter the failsafe mode, do the following:

1. Turn on the Robot by pressing the power button for 10 seconds.
2. Wait a minute.
3. To access the router using an Ethernet cable, from the OPC, run the following command:

```
ssh root@192.168.1.1
```

> **Notice**
> Make sure that the OPC has a static IP address in the `192.168.1.0/24` subnet.

You are now in the failsafe mode.

9.11.1 Changing the router password

To change the router password , do the following:

1. To mount the root filesystem, run the following command:

```
mount_root
```

2. To start the process, run the following command:

```
passwd
```

3. In the `New password` prompt, enter your new password.

> **Notice**
> Make your password strong.

4. To reboot the router, run the following command:

```
reboot
```

Your password is changed.

9.11.2 Removing the installed packages

To remove the installed packages, run the following command:

```
firstboot
```

After the packages are removed, you must configure the router using the `anymal-router setup` utility.

▶ *For more information, see "10.7 Reset the router to factory default settings" on page 301*

9.11.3 Reconfiguring the router

To reconfigure the router, do the following:

1. To mount the root filesystem, run the following command:

```
mount_root
```

2. To access configuration files in ***/etc/config/***, run the following command (for example, for the `wireless` file):

```
vim /etc/config/wireless
```

3. Change the configuration options.
4. To reboot the router, run the following command:

```
reboot
```

Your router is reconfigured.

9.12 Robot temperature too high

The warning in the **Health Monitoring** tab shows the temperature of the Robot is too high.

▶ *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

The Robot has temperature sensors and a cooling system that prevents the Robot from overheating.

In case of overheating, make sure you operate the Robot in an environment specified by the Robot environmental specifications. Remove the Robot from an environment with temperatures above the specifications.

▶ *For more information, see "12.1 Robot environmental specifications" on page 306*

If this does not help, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.13 The Robot does not charge

If the Robot does not charge, follow these steps:

1. Ensure the Robot is connected to the charging device:
   - If using the charging socket, ensure the charging cable is correctly connected to the charging socket.

- ▶ *For more information, see "8.1.4 How to charge the Robot battery using the charging socket" on page 199*
- If using the docking station, ensure the Robot docking socket is correctly connected to the docking station.
- ▶ *For more information, see "8.1.5 How to charge the Robot battery using the docking station" on page 199*

2. Check the Robot emergency stop.
   a. Ensure the Robot emergency stop is released.

> **Notice**
> The Robot will not charge if the emergency stop is engaged.

   b. Try to charge the Robot.
   If the Robot does not charge, try the next step.
3. Check the GUI **Battery status** bar.
   a. From the operator GUI, select the **Robot status** bar.
   ▶ *For more information, see "3.2.3 Robot status panel" on page 78*
   b. Check the **battery status indicator** for warnings.
   c. Try to charge the Robot.
   If the Robot does not charge, try the next step.
4. Check if the Robot battery is not too hot.

> **Notice**
> The battery cannot be charged if it is too hot. The battery needs to cool down before charging can start. You are notified of the charging state in the operator GUI.

5. Force charge the Robot battery.
   a. Ensure the Robot emergency stop is released.
   b. Ensure that the Robot battery is correctly installed.
   c. Ensure the battery charger is connected to a suitable power outlet.
   d. Connect the Robot to the battery charger.
   e. Press and hold the **Force Charging** button on the battery charger until the battery charger **Charging** indicator LED turns on.
   f. Release the **Force Charging** button on the battery charger. The battery will start to charge.

> **Notice**
>
> If the battery charger **Charging** indicator LED does not turn on after following these steps, the battery must not be used.
>
> To order replacement parts or schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

> **Warning**
>
> Risk of fire or flammable materials!
>
> During charging, monitor the battery temperature. If the battery become excessively hot, charging stops automatically.

g. Wait until the battery charger **Full charge** indicator LED turns on.
h. Disconnect the battery charger and resume operation.
If the battery does not charge, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.14 Time information of the Robot is wrong

You have to synchronize the clocks for both of the Robot's onboard computers. If the time synchronization does not work correctly, the GUI shows a warning in the **Diagnostics** tab.

▶ *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

To synchronize the time automatically:

1. Ensure the Robot can access the internet.
   ▶ *For more information, see "7.1 Connect the Robot to an on-site wireless network" on page 181*
2. Ensure the Robot can access pool.ntp.org.
3. Restart the Robot.
   The Robot synchronizes the time.

If the time synchronization does not work, you need to do one of the following:

- Synchronize the time manually using an internet access.
- If there is no internet access, synchronize the time manually.

To synchronize the time manually:

1. Connect your computer to the Robot.
   ▶ *For more information, see "5.5 Connect the operator computer to the Robot network" on page 118*
2. Open a terminal session.
3. Connect to the LPC by running the following command:

```
ssh integration@<lpc-ip-address>
```

Tip

Replace `<lpc-ip-address>` with the IP address of the LPC.

4. Stop the software by running the following command:

```
anymal_services stop
```

5. You can update the LPC clock by doing one of the following:
   - Update the date and time manually by running the following command:

```
sudo date -s "2 OCT 2022 18:00:00"
sudo hwclock --systohc
```

Tip

Replace the date and time with your current time.

   - Update the date and time using google.com by running the following command:

```
sudo date -s "$(wget -qSO- --max-redirect=0 google.com 2>&1 | grep Date: | cut -d' ' -f5-8)Z"
sudo hwclock --systohc
```

6. Restart the Robot.

   The Robot synchronizes the time.

9.15 Unspecific software issues

If you experience software issues, check that the:

- Software release version on your Robot and computers match.
- Software installations contain the latest patches.
- Software packages do not conflict.

To check for these issues, follow these steps for the operator computer, locomotion computer, and navigation computer:

1. Open a terminal session.
2. Run the following command.

```
cat /etc/apt/sources.list.d/any*.list
```

Check that the installed software release versions match across the operator computer, locomotion computer, and navigation computer.

3. Ensure the software is not running on the Robot computers.
   - ▶ *For more information, refer to the ANYbotics Software Guide.*
4. Ensure the computer is connected to the internet.
   - ▶ *For more information, see "10.6.1 Share the internet connection from the OPC to the Robot" on page 295*
5. Update the list of package repositories by running the following command:

```
sudo apt update
```

   If the command reports issues, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

6. Upgrade the software packages by running the following command:

```
sudo apt upgrade
```

   This command returns a list with all components that will be updated.

7. If you agree, confirm the upgrade of the packages with the character `y` followed by the `Enter` key.
8. Ensure that there are no unused dependencies installed on the robot by running the following command:

```
sudo apt autoremove
```

9. If you agree, confirm the removal of the packages with the character `y` followed by the `Enter` key.
10. Clear local package files by running the following command:

```
sudo apt autoclean
```

11. Restart the Robot and the operator computer.

9.16 Water inside the Robot

The warning in the **Health Monitoring** tab shows there is water inside the Robot.

▶ *For more information, see "3.2.3.1 Diagnostics and health monitoring" on page 79*

The Robot detects leaks of its sealed compartments, for example, caused by:

- Submerging the Robot into deep water
- Heavy rain
- Salt water

▶ *For more information, see "12.1 Robot environmental specifications" on page 306*

In case of ingress, immediately remove the Robot from the environment and contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

9.17 Zoom camera does not work

If the zoom camera does not work, follow these steps:

1. Ping the zoom camera from the locomotion computer.

   a. Open a terminal on the locomotion computer.
   b. Run the following command.

```
ping 192.168.1.120
```

   The expected output of this command should look like the following.

```
PING 192.168.1.120 (192.168.1.120) 56(84) bytes of data.
64 bytes from 192.168.1.120: icmp_seq=1 ttl=64 time=1.24 ms
64 bytes from 192.168.1.120: icmp_seq=2 ttl=64 time=1.05 ms
```

   c. Copy the output of this command and save to a text file.

2. Access the zoom camera web interface.

   a. Open a terminal on the operator computer.
   b. Run the following command.

```
ssh -L 8080:192.168.1.120:80 integration@anymal-<anymal-name>-lpc
```

> **Tip**
> Replace `<anymal-name>` with the name of your Robot.

   c. Open a web browser on the operator computer.
   d. Navigate to `localhost:8080`.
   e. Login with the following username and password.
      - **Username**: `admin`
      - **Password**: `anymalPayload`
   f. Take a screenshot of all browser tabs

3. Run the GStreamer pipeline.

   a. Open a terminal on the locomotion computer.
   b. Run the following command.

```
sudo apt install gstreamer1.0-tools
```

   c. Run the following command.

```
gst-launch-1.0 rtspsrc
location=rtsp://admin:anymalPayload@192.168.1.120:554/z3-1.sdp
latency=0 ! "application/x-rtp, media=(string)video" ! decodebin !
videoconvert ! appsink
```

   d. Copy the output of this command and save to a text file.

4. Send the screenshots and text files to customer support to help solve the issue.

10 SERVICE AND MAINTENANCE

It is important that you regularly service and maintain your Robot.

Warning

Unless required for specific tests, you must remove the battery and battery charger from the Robot when servicing and maintaining the Robot.

Warning

While handling the Robot when it is unpowered, or it is being maintained, caution must be used around the pinch points of the Robot.

Caution

After any maintenance or service tasks have been completed, you must test all safety functions for correct operation.

► *For more information, see "1.5 Safety functions" on page 20*

10.1 Inspection checks

The inspection checks below should be carried out prior to using the Robot and regularly during extended periods of operation.

- Check for software and firmware updates available for the Robot.
- Check how clean the Robot is and clean if necessary. In particular, check the following areas for excessive soiling:
  - Are the glasses protecting the sensors and cameras dirty? Extensive soiling can decrease the performance of the optical sensors.
  - Are the joints dirty such that their movement is hindered? Excessive soiling can increase the friction of moving parts and therefore decrease their performance and increase wear.
  - Is the docking socket dirty? The autonomous charging system may not work reliably if the docking socket is dirty.
- Check for visible damage or wear in the following areas:
  - Robot feet
  - Robot body

- Battery
- Inspection payload
- Hoist points

If any damage is observed during inspection, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.2 Scheduled inspection checks

Inspection checks should be done at scheduled intervals. These checks ensure the reliability and safe operation of the Robot.

The following checks should be done every three months or after the Robot has fallen:

- Inspect the Robot feet for damage and wear.
- Inspect the Robot for damage.
- Inspect cameras and lenses for damage.

The Robot safety functions must be tested at least once every 12 months.

► *For more information, see "10.2.1 Safety functions" on page 277*

10.2.1 Safety functions

The Robot has several safety functions which must be maintained to ensure the safe operation of the Robot.

The following tests must be done after maintenance, after the Robot has had a fall or once per year to guarantee the reliability of the Robot and related systems.

- Robot emergency stop
- Delayed start and danger zone active warning light

10.2.1.1 Test the Robot emergency stop

The Robot emergency stop must be checked in the following circumstances to guarantee the reliability of the system.

- After maintenance.
- After the Robot has fallen.
- Or at least once per year.

The following checks should be made, using the following order:

1. Ensure that the battery is inserted correctly into the Robot.
2. Ensure that the Robot emergency stop is not engaged.

3. Ensure that the Robot emergency stop diagnostic indicator light is off.
   - ▶ *For more information, see "2.3.6 Diagnostic lights" on page 57*
4. Press the Robot emergency stop button.
5. Check that the Robot emergency stop diagnostic indicator light is on.
6. Release the Robot emergency stop button.
7. Check that the Robot emergency stop diagnostic indicator light is off.

If the test is not successful, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.2.1.2 Test the delayed start and the danger zone active warning light

> **Caution**
>
> Risk of injury!
>
> Actuators must be powered for this test. Do not enter the danger zone when the actuators are powered.

The Robot delayed start and danger zone active warning light must be checked in the following circumstances to guarantee the reliability of the system.

- After maintenance
- After the Robot has fallen.
- Or at least once per year

The following checks should be made, using the following order:

1. Ensure no emergency stop button is engaged.
2. Ensure that the Robot is powered and the drives are disabled.
3. Check that the emergency stop diagnostic indicator light is on.
   - ▶ *For more information, see "2.3.6 Diagnostic lights" on page 57*
4. Enable the actuators.
   a. Ensure the Robot is controlled using the ANYbotics Workforce app.
   b. Select **Stand** from the Robot control menu.
   - ▶ *For more information, see "8.3.5 How to change operational modes using the ANYbotics Workforce app" on page 207*
5. Check that both danger zone active warning light groups are on.
   You can see this by checking the spacing between the individual light sources.
6. Check that the emergency stop diagnostic indicator light stays on for at least nine seconds then turns off.
7. Check that both danger zone active warning light groups are still on.

If any of the tests fail, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.2.1.3 Test the GUI cut power

Caution

Risk of injury!

Actuators must be powered for this test. Do not enter the danger zone when the actuators are powered.

The GUI cut power must be checked in the following circumstances to guarantee the reliability of the system.

- After maintenance
- After the Robot has fallen.
- Every time the remote control transceiver is installed.
- Or at least once per year

The following checks should be made, using the following order:

1. Ensure that the tablet is powered and indicates that it is connected to the Robot.
2. Ensure that the Robot is lying on the floor in a stable position.
3. Ensure that the Robot is powered and the drives are enabled.
4. Slide the GUI cut power button.
   ▶ *For more information, see "8.5.2 How to stop the Robot using the GUI cut power" on page 232*

   The danger zone active warning light should turn off.

If the test is not successful, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.2.2 Cameras and lenses

> **Caution**
>
> Risk of injury!
>
> Damaged or dirty cameras and sensors can negatively impact the capability of the Robot to avoid obstacles.
>
> This increases the risk of damaging the Robot and the risk of the Robot walking into people.

The Robot cameras and lenses must be regularly inspected for damage.

The cameras and lenses should be inspected regularly and after the Robot has had a fall. The frequency of inspection depends on the work environment.

If any damage to the cameras and lenses is observed during inspection, stop using the Robot immediately.

To order replacement parts or schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.2.3 General Robot damage

The Robot should be inspected regularly for damage. The frequency of inspection depends on the work environment.

The Robot must be inspected for damage after it has had a fall.

If any damage to the Robot is observed during inspection, stop using the Robot immediately.

To order replacement parts or schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.2.4 Inspect feet

The Robot feet must be inspected regularly and replaced if necessary. The frequency of inspection depends on the work environment.

► *For more information, see "10.4.4 Replace the feet" on page 289*

10.3 Preventive maintenance tasks

Preventative maintenance tasks must be done to ensure the reliability of the Robot.

10.3.1 Clean the Robot and sensors

The Robot and sensors must be cleaned regularly to guarantee correct operation. The frequency of cleaning depends on the work environment.

Tools and parts required:

- Sponge
- Water
- Glass cleaner (non-corrosive)
- Isopropanol or ethanol
- Soft cloth
- Compressed air

Warning
The battery must be attached to the Robot to avoid water entering the battery connector or the Robot.

Notice
Do not use high pressure water to clean the Robot.

High pressure water can damage the Robot components.

Use a low pressure water spray to carefully rinse the Robot if required.

Notice
Do not use a cloth if there is dust or sand on glass sensor covers.

Particles may scratch the glass sensor covers when wiped with a cloth.

To clean the Robot and sensors, follow these steps:

1. Ensure that the Robot is turned off.
2. Disconnect the battery charger.
3. Using water and a sponge, carefully clean the Robot body.
4. Using compressed air, remove dust from the Robot body and glass sensor covers.
5. Using glass cleaner and a soft cloth, carefully clean the following areas of the Robot:

- Depth cameras
- Wide angle cameras
- LIDAR unit

6. If installed, clean the following areas of the inspection payload:

   - Inspection payload cameras
   - Inspection payload LED light
   - Inspection payload microphone

   Isopropanol or ethanol can be used to remove heavy soiling from glass sensor covers.

> **Notice**
> Do not apply glass cleaner directly to the microphone orifice.
> Apply glass cleaner to a soft cloth and carefully clean the microphone orifice.

7. If required, reset the Robot emergency stop.
8. Resume operation.

If any damage to the Robot or sensors is observed during cleaning, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.3.2 Clean fans and fan guards

The fans and fan guards should be cleaned regularly. The frequency of cleaning depends on the work environment.

To complete this maintenance task, the following items are required:

- Soft brush
- Soft cloth

To clean the Robot fan guards and filters, follow these steps:

1. Remove the Robot battery and disconnect the battery charger.
2. Using a soft brush and soft cloth, carefully clean the following fans and fan guards:
   - 1 x main body fan and fan guards.
   - 8 x leg fans and fans guards.
3. Visually inspect the heat sinks.
   If they are found to be excessively dirty or blocked, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.
4. Insert the battery and, if required, reset the Robot emergency stop.

5. Resume operation.

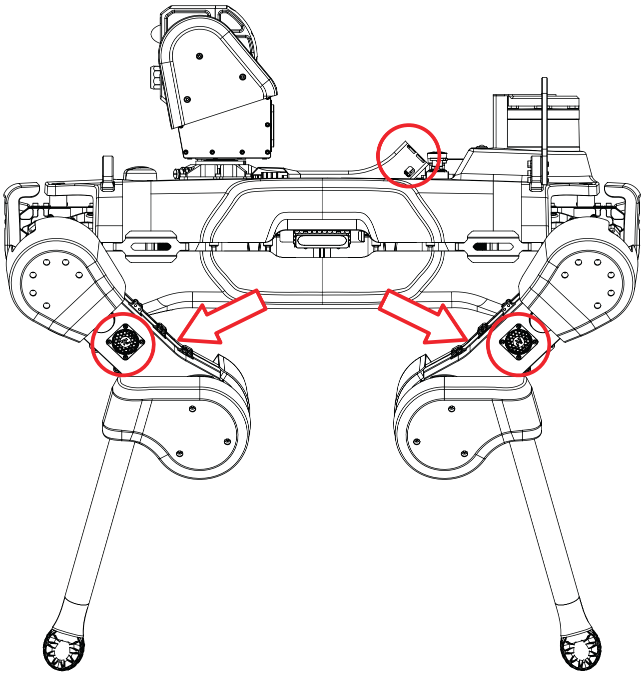


Figure 65 - Location of fans and filters

If any damage to the fans or fan guards is observed during cleaning, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.3.3 Clean the docking socket

The Robot docking socket should be cleaned regularly to guarantee correct operation. The frequency of cleaning depends on the work environment.

Tools and parts required:

- Soft brush
- Sponge
- Water
- Soft dry cloth

> **Notice**
> Do not use high pressure water to clean the Robot docking socket.
> High pressure water can damage the docking socket components.

To clean the Robot docking socket, follow these steps:

1. Ensure that the Robot is turned off.
2. Disconnect the battery charger.
3. Disconnect the Robot from the docking station.
4. Turn the Robot over to give access to the docking socket.
   Positioning the legs correctly helps turning over the Robot.
5. Using a soft brush, remove any debris from the docking socket.
6. Using a damp cloth or a sponge, carefully clean the docking socket.
7. Using a soft dry cloth, carefully dry the docking socket.
8. Turn the Robot over.
9. If required, reset the Robot emergency stop.
10. Resume operations.

If any damage to the Robot docking socket is observed during cleaning, stop using the Robot immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.3.4 Clean the docking station

The Robot docking station should be cleaned regularly to guarantee correct operation.. The frequency of cleaning depends on the work environment.

Tools and parts required:

- Soft brush
- Sponge
- Water
- Soft dry cloth

Notice

Do not use high pressure water to clean the docking station.

High pressure water can damage the docking station.

To clean the Robot docking station, follow these steps:

1. Turn off the power to the docking station.
2. Disconnect the docking station from the Robot.
3. Disconnect the docking station from the battery charger.
4. Using a soft brush, remove any debris from the docking station.
5. Using a damp cloth or a sponge, carefully clean the cone of the docking station.
6. Using a soft dry cloth, carefully dry the docking station.
7. Connect the docking station to the battery charger.

8. Turn on the power to the battery charger.

If any damage to the docking station is observed during cleaning, stop using the docking station immediately.

To schedule a repair, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

10.4 Replace parts

Some parts of the Robot may have to be replaced periodically when worn or damaged.

The following parts can be replaced on the Robot:

- Robot top shell
- Robot bottom shell
- Robot protectors
- Rollover bar
- Hoist points

Replacement of these parts should only be performed by following the instructions in this manual.

10.4.1 Replace the Robot top shell

Caution

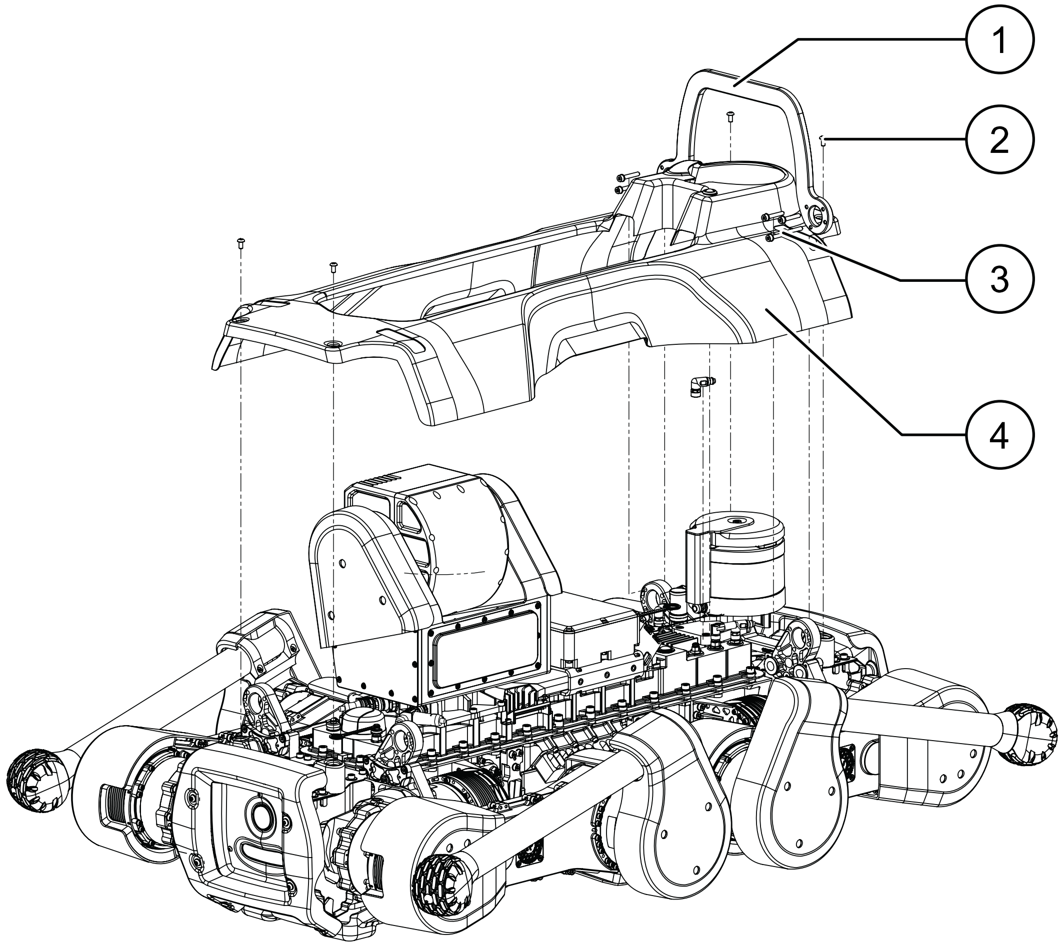
Risk of injury!

- Do not operate the Robot without the top shell fitted.
- Do not alter or adjust any of the exposed internal components while the top shell is being replaced.

If damaged, the top shell must be replaced immediately to prevent damage to the Robot.

Tools and parts required:

- Replacement top shell
- 2.5 mm Hex Allen key (torque 1.1 Nm)
- 3 mm Allen key (torque 2.3 Nm)
- Loctite™ 222
- Loctite™ 243



1	Rollover bar
2	M4 screws (4)
3	M4 screws (8)
4	Top shell

Figure 66 - Robot top shell replacement

To replace the top shell, follow these steps:

1. Disconnect the battery charger.
2. Remove the Robot battery.
   ► *For more information, see "4.2 Insert the Robot battery" on page 103*
3. Turn the inspection payload sideways.
4. Remove the eight screws (four each side) holding the rollover bar.
5. Remove the four screws holding on the top shell.
6. Lift the top shell off the Robot and replace if required.
7. Re-attach the rollover bar.
   ► *For more information, see "10.4.5 Replace the rollover bar" on page 290*
8. Apply Loctite™ 222 only to the M4 screws of the top shell.

9. Using a 2.5 mm Allen key, tighten the M4 screws to 1.1 Nm.
10. Insert the battery and, if required, reset the Robot emergency stop.
11. Resume operations.

10.4.2 Replace the Robot bottom shell

The Robot bottom shell provides protection for the underside of the Robot and the battery. The bottom shell must be replaced if damaged.

Tools and parts required:

- 4 mm Allen key (torque 1.1 Nm)
- Loctite™ 222

The procedure for removing and replacing the bottom shell is same procedure that is used for accessing and inserting the battery.

► *For more information, see "4.2 Insert the Robot battery" on page 103*

10.4.3 Replace protectors

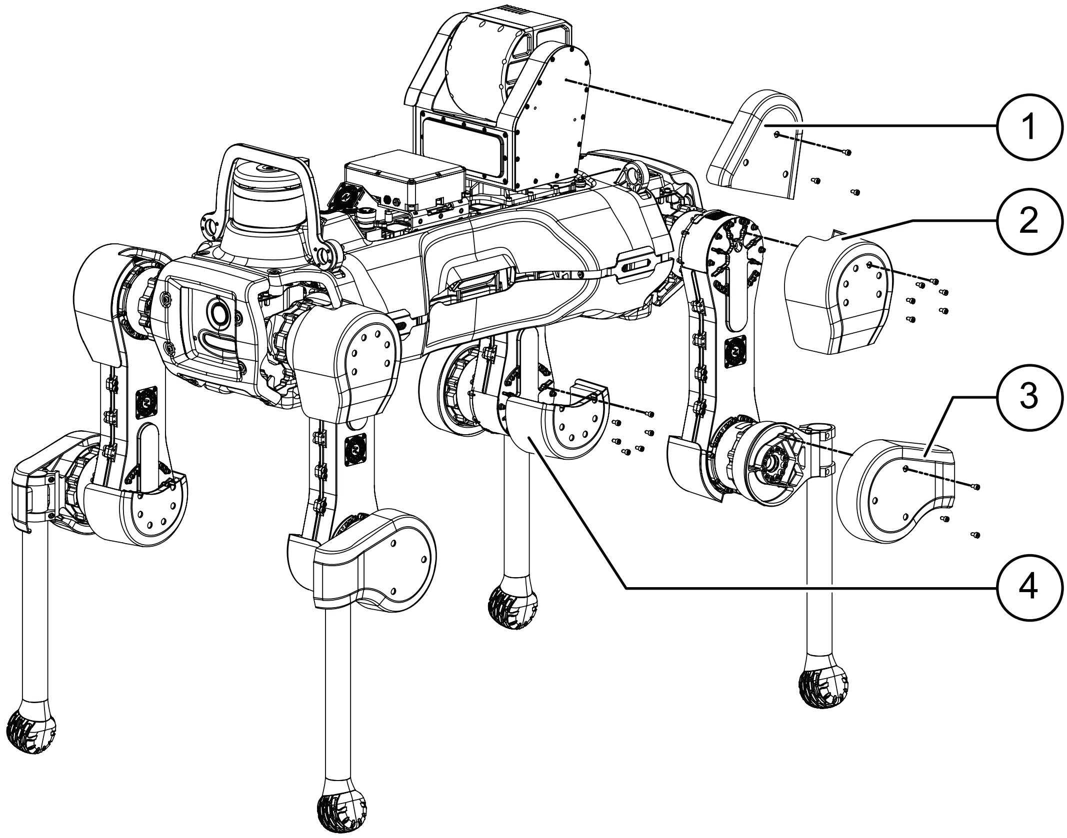
If damaged, the protectors must be replaced immediately to prevent damage to the Robot.

Protectors can be found in the following places:

- Inspection payload
- Leg - hip joint
- Leg - knee outside
- Leg - knee inside

Tools and parts required:

- 3 mm Allen key (torque 2.3 Nm)
- Loctite™ 243
- Replacement protectors



1	Inspection payload protector
2	Hip joint protector
3	Outside knee protector
4	Inside knee protector

Figure 67 - Location of Robot protectors

To replace the Robot protectors, follow these steps:

1. Disconnect the battery charger.
2. Remove the Robot battery.
   - ► *For more information, see "4.2 Insert the Robot battery" on page 103*
3. Unscrew the screws holding the protector to the actuator or inspection payload.
4. Remove the protector and replace it.
5. Apply Loctite™ 243 to the M4 screws.
6. Using a 3 mm Allen key, tighten the M4 screws to 2.3 Nm.
7. Insert the battery and, if required, reset the Robot emergency stop.
8. Resume operations.

10.4.4 Replace the feet

The Robot feet must be inspected regularly and replaced if necessary. The frequency of replacement depends on the work environment.

Replace the sole according to its level of wear, as demonstrated in Figure 68.

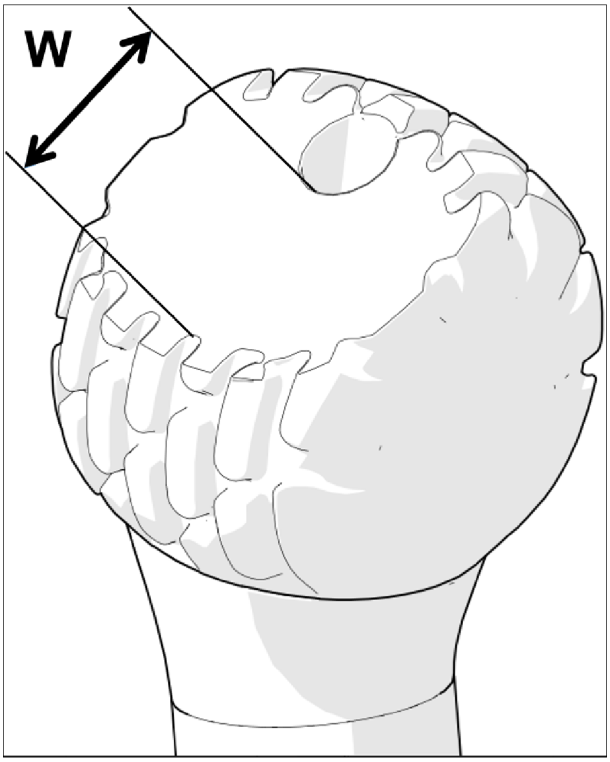
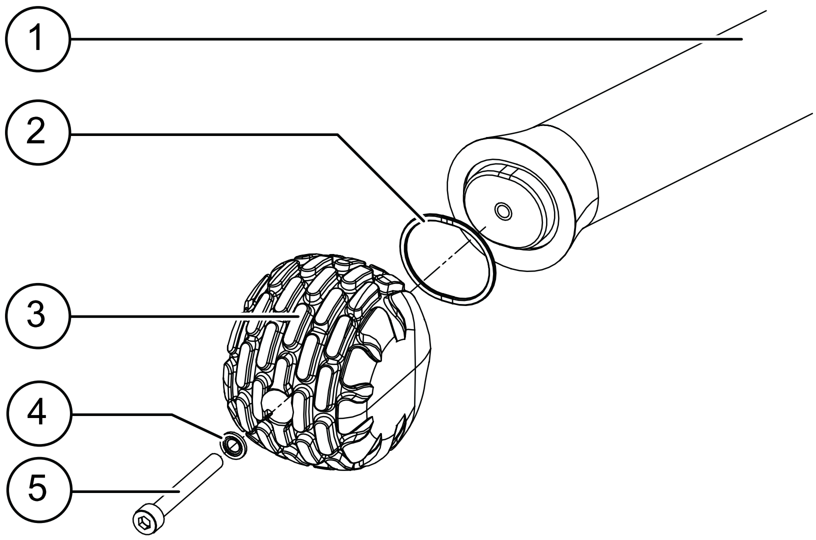


Figure 68 - Sole of the Robot foot

If the distance between the edge of the screw hole and the border of the worn sole is more than 22 mm, replace the sole.

Tools and parts required:

- Replacement Robot foot and rubber 'O' ring (NBR70 28x1.5)
- 4 mm Allen key (torque 4.8 Nm)



1	Leg shank
2	Rubber '0' ring
3	Foot
4	Washer
5	M5 screw

Figure 69 - Robot foot assembly

To replace the Robot feet, follow these steps:

1. Disconnect the battery charger.
2. Remove the Robot battery.
3. Remove the M5 screw and washer on the sole of the Robot foot.
4. Clean the hoof and its '0' ring groove from dirt with isopropanol.
5. Replace the Robot foot and rubber '0' ring.
6. Using a 4 mm Allen key, tighten the M5 screw with the dry sealing washer to 4.8 Nm.
7. Insert the battery and, if required, reset the Robot emergency stop.
8. Resume operations.

10.4.5 Replace the rollover bar

If damaged, the rollover bar must be replaced immediately to prevent damage to the LIDAR unit, diagnostic indicator light and danger zone active warning light.

Warning

Risk of serious injury or death!

The rollover bar protects safety critical components of the Robot.

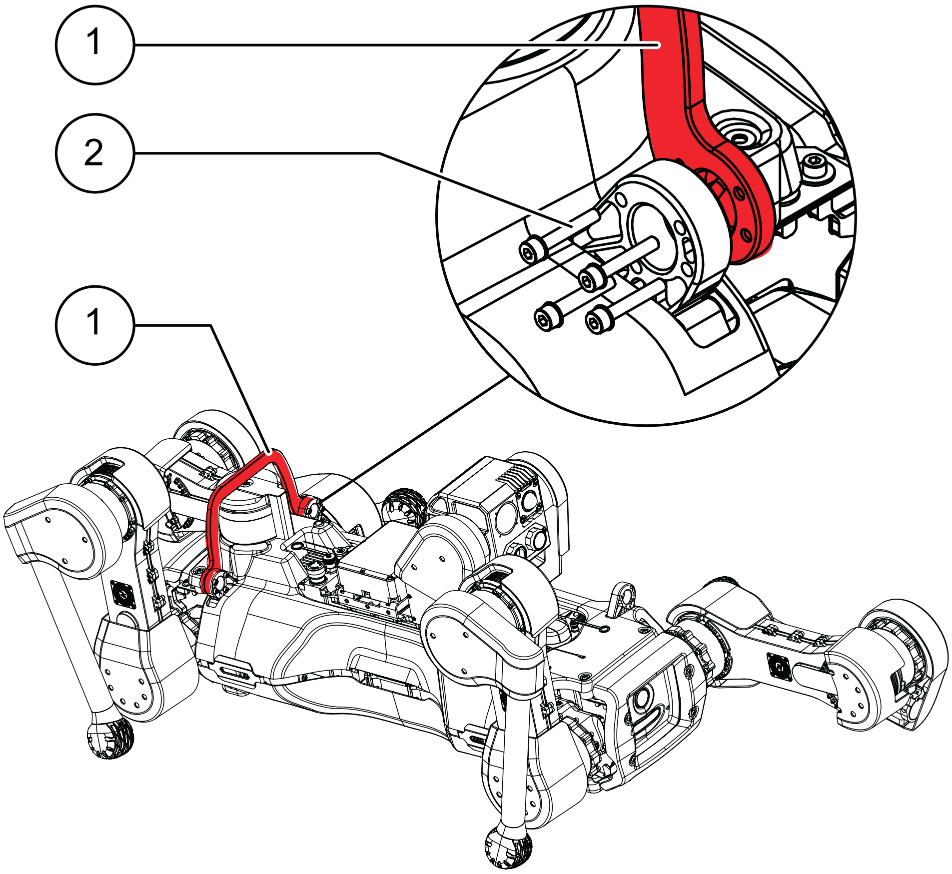
Do not operate the Robot without the rollover bar fitted.

If the rollover bar is damaged, a test of the danger zone active warning light should be performed before resuming operation.

▶ *For more information, see "10.2.1.2 Test the delayed start and the danger zone active warning light" on page 278*

Tools and parts required:

- Replacement rollover bar
- 3 mm Allen key (torque 2.3 Nm)
- Loctite™ 243



1	Rollover bar
2	M4 screws (4)

Figure 70 - Replacing the rollover bar

To replace the rollover bar, follow these steps:

1. Disconnect the battery charger.
2. Remove the Robot battery.
   ▶ *For more information, see "4.2 Insert the Robot battery" on page 103*
3. Remove the M4 screws holding the rollover bar. There are 8 M4 screws, with 4 screws on each side.
4. Replace the rollover bar.
5. Apply Loctite™ 243 to the M4 screws then place the screws in the rollover bar.
6. Using a 3 mm Allen key, tighten the M4 screws to 2.3 Nm.
7. Insert the battery and, if required, reset the Robot emergency stop.
8. Resume operations.

10.4.6 Replace the hoist points

Warning

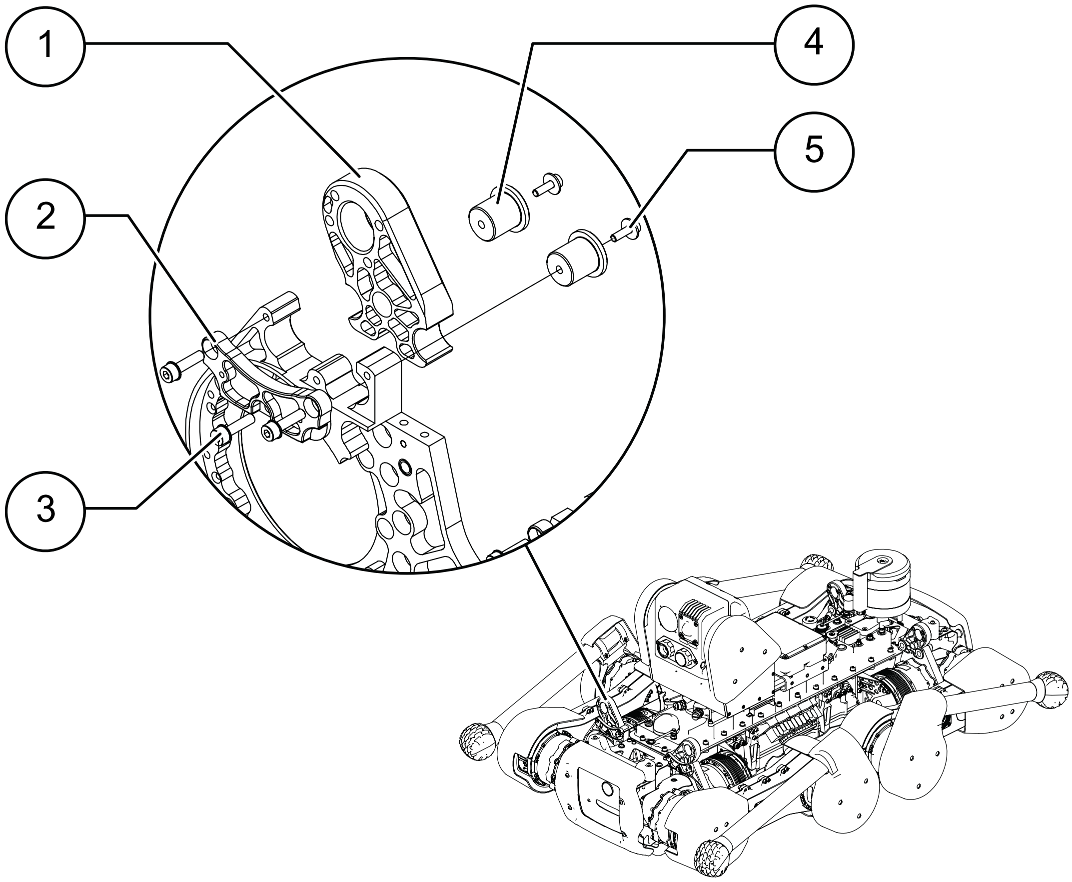
Risk of serious injury or death!

Do not lift the Robot with damaged hoist points.

If damaged, the hoist points should be replaced immediately before lifting the Robot.

Tools and parts required:

- Replacement hoist point and backing plate
- Replacement M4 screw, washer and plastic bushing
- 3 mm Allen key (torque 2.3 Nm)
- 2.5 mm Allen key (torque 1.1 Nm)
- Punch and soft mallet
- Loctite™ 243



1	Hoist point
2	Backing plate
3	M4 screws (3)
4	Plastic bush (2)
5	M3 screws (2)

Figure 71 - Hoist point replacement

> **Notice**
> Plastic bushings have a press fit inside the Robot body and hoist point.
>
> A punch or clamp may need to be used to push the plastic bushings out of the Robot body and hoist point.

To replace the Robot hoist points, follow these steps:

1. Disconnect the battery charger.
2. Remove the Robot battery.
3. Remove the Robot top shell.

▶ *For more information, see "10.4.1 Replace the Robot top shell" on page 285*

4. Remove the two M3 screws and washers attaching the plastic bushings to the backing plate.
5. Remove the three M4 screws and washers attaching the backing plate to the Robot body.
6. Remove the two plastic bushings.
7. Slide the hoist point out of the Robot body.
8. Slide the replacement hoist point into the Robot body.
9. Push the replacement plastic bushings into the Robot body.
10. Replace the backing plate by applying Loctite™ 243 to the M4 screws and tightening by hand.

> **Notice**
> Do not torque the M4 backing plate screws until the plastic bushings are installed.

11. Apply Loctite™ 243 to the M3 screws.
12. Insert the M3 screws and washers into the plastic bushings and tighten to 1.1 Nm.
13. Tighten the M4 backing plate screws to 2.3 Nm.
14. Re-attach the top shell.
15. Remount the rollover bar.
16. Insert the battery and, if required, reset the Robot emergency stop.
17. Resume operations.

10.5 Store the Robot and battery

Correct storage of the Robot and battery will prolong the life of the Robot and guarantee the correct operation of the Robot and sensors.

10.5.1 Store the Robot

When not in use, the Robot must be stored using the following criteria:

- Dry and secure location
- Stored in the Transport Box.
- Storage temperature range 10 °C to 30 °C
- Storage relative humidity 50%
- Battery is charged above 50%.
- For storage of 2 weeks or more, you must:
  - Remove the battery from the Robot.
  - Check all safety features before using the Robot.
  - Charge the battery.
  - ▶ *For more information, see "10.5.2 Store the battery" on page 295*

10.5.2 Store the battery

When not connected to the Robot, the battery should be properly stored.

Follow these guidelines for safe battery storage:

- Store the battery at room temperature.
- Store the battery charged 80% to 90% capacity. Recharge the battery every six months when not in use.
- Store the battery in a dry environment.
- Store the battery in a flame retardant container.
- Store the battery separated from anything hazardous, for example, explosives, combustibles, or any other highly flammable material.
- Do not expose the battery to direct sunlight or other heat sources for extended periods.

10.6 Upgrade the software and firmware of the Robot

The Robot software and firmware should be regularly updated to ensure the correct operation and data security of the Robot.

During the upgrade, the Robot must be connected to the internet. One way to connect the Robot to the internet is with a shared connection, especially if the Robot is configured as an access point (AP).

Using a shared internet connection from the operator computer (OPC) enables the locomotion computer (LPC) and navigation computer (NPC) to access the internet.

10.6.1 Share the internet connection from the OPC to the Robot

You can create a shared internet connection on the operator computer (OPC) that the Robot can use.

To create a shared internet connection, follow these steps:

1. Open a terminal on the OPC.
2. Run the following command to open the connection editor.

```
nm-connection-editor
```

3. Select '+', select **Ethernet** and then select **Create**.
4. On the dialog, enter the new connection name as `Shared Internet Connection`.
5. Select the **IPv4 Settings** tab.
6. In the **Method** drop down list, select *Shared to other computers*.
7. To the right of the **Address** list, select **Add**.
8. Enter `192.168.0.1` as the IP address.
9. Enter `255.255.255.0` as the Netmask.
10. Select **Save**.
11. On the **Edit Shared Internet Connection** dialog, select **Save**.
12. Close the **Network Connections** dialog.

13. Close the terminal on the OPC.

The shared internet connection is ready for use.

10.6.1.1 Use the shared internet connection

After you create a shared internet connection on the operator computer (OPC), you must share it with the Robot.

To share the internet connection with the Robot, follow these steps:

1. Turn on the Robot.
2. Connect the OPC to the internet through Wi-Fi.
3. Connect the OPC to the Robot using the supplied ethernet cable.
4. On the OPC, open the **Settings** and select the **Network** tab.
5. From the **Ethernet** connection list, select *Shared Internet Connection*.
6. Close the **Settings**.

The OPC internet connection is now shared with the Robot.

10.6.2 Upgrade the Robot software

The Robot is supplied with software pre-installed.

To upgrade the Robot software, you have two options:

- Upgrade to a new release, which comes with new features.
- Install the latest software, including all patches, for the currently selected release.

> **Notice**
> The software upgrade has to be done on all onboard computers and all operator computers. Compatibility across different software versions can not be guaranteed.

To connect from the operator computer to the locomotion computer run the following command:

```
ssh integration@anymal-<anymal-name>-lpc
```

To connect from the operator computer to the navigation computer run the following command:

```
ssh integration@anymal-<anymal-name>-npc
```

10.6.2.1 Upgrade to a new release

To upgrade software on the operator computer, navigation computer or locomotion computer, follow these steps:

1. Select the release to install from the Software Release Notes (the latest release is recommended).
2. Open a terminal on the computer that you want to update.
3. Run the following command.

> **Tip**
>
> Replace `<xx.yy>` with the desired or selected software release number.

```
sudo sh -c 'echo "deb [arch=amd64] https://packages-ros.anybotics.com/ros/release-<xx.yy>/ubuntu $(lsb_release -sc) main" > /etc/apt/sources.list.d/any-ros.list'
```

4. Add the preferred release version to the software sources.

> **Tip**
>
> Replace `<xx.yy>` with the desired or selected software release number.
>
> Replace `<customer_type>` with:
>
> - `anymal` if you are a regular customer.
> - `anymal-research-software` if you are a research customer.
> - Your organization name if a special PPA was created for you.

```
sudo sh -c 'echo "deb [arch=amd64] https://packages.anybotics.com/<customer_type>/release-<xx.yy>/ubuntu $(lsb_release -sc) main" > /etc/apt/sources.list.d/anymal.list'
```

5. Ensure the software is not running on the Robot computers.
   - ▶ *For more information, refer to the ANYbotics Software Guide.*
6. Ensure the computer is connected to the internet.
   - ▶ *For more information, see "10.6.1 Share the internet connection from the OPC to the Robot" on page 295*
7. Update the list of package repositories by running the following command:

```
sudo apt update
```

   If the command reports issues, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

8. Upgrade the software packages by running the following command:

```
1 | sudo apt upgrade
```

This command returns a list with all components that will be updated.

9. If you agree, confirm the upgrade of the packages with the character `y` followed by the `Enter` key.
10. Ensure that there are no unused dependencies installed on the robot by running the following command:

```
1 | sudo apt autoremove
```

11. If you agree, confirm the removal of the packages with the character `y` followed by the `Enter` key.
12. Clear local package files by running the following command:

```
1 | sudo apt autoclean
```

13. Restart the Robot and the operator computer.

10.6.2.2 Install the latest software

To install the latest software, including all patches, for the currently selected release on the operator computer, navigation computer or locomotion computer, follow these steps:

1. Ensure the software is not running on the Robot computers.
   - ▶ *For more information, refer to the ANYbotics Software Guide.*
2. Ensure the computer is connected to the internet.
   - ▶ *For more information, see "10.6.1 Share the internet connection from the OPC to the Robot" on page 295*
3. Update the list of package repositories by running the following command:

```
1 | sudo apt update
```

If the command reports issues, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/.

4. Upgrade the software packages by running the following command:

```
1 | sudo apt upgrade
```

This command returns a list with all components that will be updated.

5. If you agree, confirm the upgrade of the packages with the character `y` followed by the `Enter` key.
6. Ensure that there are no unused dependencies installed on the robot by running the following command:

```
1 | sudo apt autoremove
```

7. If you agree, confirm the removal of the packages with the character `y` followed by the `Enter` key.
8. Clear local package files by running the following command:

```
1 | sudo apt autoclean
```

9. Restart the Robot and the operator computer.

10.6.3 Upgrade the actuator firmware

Notice
Do not power-cycle the actuators during the firmware update.
Ensure that the Robot is lying on the ground during the firmware update.

To update the actuator firmware, follow these steps:

1. Enter the following command to power the actuators:

```
rosservice call /pdb_driver/set_power_line 1 1
```

Notice
The actuators will not power up if the emergency stop is engaged. Ensure that the emergency stop is disengaged.

▶ *For more information, see "1.5.1 Robot emergency stop" on page 21*

2. Enter the following command to stop the locomotion computer software stack:

```
sudo systemctl stop anymal-sw-stack@lpc.service
```

3. Enter the following command to get the EtherCAT interface:

```
grep -o 'bus:.*' /etc/robot/hw.yaml | head -n 1 | sed 's/bus: //'
```

This retrieves the EtherCAT interface, for example `enp6s0`, which is needed in the next step.

4. Enter the following command to run the ANYdrive Firmware Updater:

```
anydrive-firmware-cli update --interface <EtherCAT interface>
```

Tip
Replace `<EtherCAT interface>` with the code retrieved in step 3.

Notice
The ANYdrive Firmware Updater requires Internet access.

The tool shows and installs all available updates for actuators.

5. After all the actuators are updated, reboot the Robot to load the new firmware.

10.6.4 Upgrade the PDB firmware

To update the PDB firmware, follow these steps:

1. Ensure the Robot is powered and lying on the floor or suspended from a crane.
2. Connect to the locomotion computer using SSH:

```
ssh integration@anymal-<anymal-name>-lpc
```

> Tip
> Replace `<anymal-name>` with the name of your Robot.

3. Enter the following command to start the upgrade:

```
cd /usr/share/pdb-firmware/ && ./pdb_update_36.bash
```

4. Wait for the script to finish the upgrade.

10.6.5 Upgrade the router firmware

The router firmware can be upgraded to the latest version. The latest image is provided with the `wcb-openwrt` package.

> Tip
> To upgrade the router firmware, you must connect to the router using an Ethernet cable.

To update the router firmware, run one of the following command:

- To set the new password to `admin`:

```
anymal-router -i 192.168.1.1 -p <password> flash
```

- To specify a different new password:

```
anymal-router -i 192.168.1.1 -p <password> flash --initial-password
<new_password>
```

A backup of the config files is created in ***{HOME}/.ros/log/<date>_router_config_backup.tar.gz***.

After the firmware is upgraded, you must configure the router using the `anymal-router setup` utility.

For more information, see "10.7 Reset the router to factory default settings" on page 301

> **Tip**
>
> To access user help for upgrading router firmware, run the following command:
>
> `anymal-router flash --help`

10.7 Reset the router to factory default settings

To reset the router to the configuration it had when it left ANYbotics, run the `anymal-router setup` command line utility.

Enter the following command:

```
anymal-router --ip <router_ip_address> --password <router_password>
setup -a <anymal_name> --bridge-ip <static_bridge_ip> --mode ap-both --
country-code <country_code>
```

<router_ip_address>	The IP address to reach the router. If you are using an Ethernet cable connection, the router is reached using IP address 192.168.1.1
<router_password>	The password of the router. By default, this is the name of the ANYmal, for example `d001`.
<anymal_name>	The anymal name which determines the SSIDs of the access points and their password. • The SSID of the 5 GHz access point will be renamed to `anymal-<anymal_name>-wifi`. • The SSID of the 2.4 GHz access point will be renamed to `anymal-<anymal_name>-wifi-2.4`. • The password for both access points will be changed to `<anymal_name>WLAN`. See the example below for further details.
<static_bridge_ip>	The IP that you want the router to use when it is set to bridge mode. By default, this is the IP address of the LPC + 2. Example: if the LPC IP address is 192.168.0.125, then the static router IP address in bridge mode is 192.168.0.127.
<country_code>	The country code of the country in which the robot is operated.

For example, this is the `anymal-router setup` command line utility for a robot **d001** which was shipped with the static LPC address 192.168.0.125. The password of the router is **generic** and the robot is being operated in Switzerland.

```
anymal-router --ip 192.168.1.1 --password generic setup -a d001 --
bridge-ip 192.168.0.127 --mode ap-both --country-code CH
```

The access points will be renamed as follows:

- The SSID of the 5 GHz access point will be renamed to `anymal-d001-wifi` with password `d001WLAN`.

- The SSID of the 2.4 GHz access point will be renamed to `anymal-d001-wifi-2.4` with password `d001WLAN`.

> **Tip**
>
> To access user help for using the `anymal-router setup` command line utility, run the following command:
>
> ```
> anymal-router setup --help
> ```

10.8 Update your software license

To keep your access to the software options which you purchased, you need to update your organization-specific software license on the computers.

To update your software license, follow these steps:

1. Download the software license to the operator computer (OPC).
2. To copy the entitlement file to the locomotion computer (LPC), enter the following command:

```
scp entitlements.yaml integration@anymal-<anymal-name>-lpc:\~/
```

3. To copy the entitlement file to the navigation computer (NPC), enter the following command:

```
scp entitlements.yaml integration@anymal-<anymal-name>-npc:\~/
```

4. To connect the LPC, enter the following command:

```
ssh integration@anymal-<anymal-name>-lpc
```

5. To connect the NPC, enter the following command:

```
ssh integration@anymal-<anymal-name>-npc
```

6. To install the entitlement file, enter the following commands on the OPC:

```
cd Downloads
sudo mv entitlements.yaml /etc/robot/entitlements.yaml
```

7. To install the entitlement file, enter the following command on the LPC and NPC:

```
sudo mv entitlements.yaml /etc/robot/entitlements.yaml
```

10.9 Calibrate the inspection payload

After the Robot falls onto the inspection payload, the axes of the inspection payload may not work correctly. The issues may include:

- Low torque

- Temperature errors
- Wrong movement of the axes

In order to calibrate the inspection payload, you need to calibrate both the motor and the axes.

10.9.1 Calibrate the motor

To calibrate the motor, follow these steps:

1. Connect to the locomotion computer using SSH:

```
ssh integration@anymal-<anymal-name>-lpc
```

> **Tip**
> Replace `<anymal-name>` with the name of your Robot.

2. Stop the running LPC software stack:

```
sudo systemctl stop anymal-sw-stack@lpc.service
```

3. Align the axis of the pan and tilt units of the inspection payload by hand to point straight.
4. Flag the calibration:

```
rosparam set pantilt_head_driver/odrive_common/force_calibration true
```

5. Restart the software:

```
sudo systemctl start anymal-sw-stack@lpc.service
```

6. Restart the emergency stop.
7. Change the operational mode of the Robot to rest.
   The inspection payload moves both axis by 45° and back.
8. Check the progress of the calibration:

```
journalctl -u anymal-sw-stack@lpc.service --follow
```

9. After the calibration is finished, stop the software again:

```
sudo systemctl stop anymal-sw-stack@lpc.service
```

10. Unflag the calibration:

```
rosparam set pantilt_head_driver/odrive_common/force_calibration false
```

11. Restart the software again:

```
sudo systemctl start anymal-sw-stack@lpc.service
```

10.9.2 Calibrate the position of the axes

The inspection payload uses absolute encoders that are mechanically aligned at production.

However, there can be a small difference in the absolute position of the axes. You can adjust the axes in a calibration file on the Robot.

> **Notice**
>
> By default, the file is stored in ***/home/integration/.ros/pantilt_offset_calib.yaml***. If the file exists, the Robot always uses the offset value from the file.
>
> You can directly edit the file or move the inspection payload manually to the desired zero position.

To calibrate the position of axes, follow these steps:

1. Connect to the locomotion computer using SSH:

```
ssh integration@anymal-<anymal-name>-lpc
```

> **Tip**
>
> Replace `<anymal-name>` with the name of your Robot.

2. Make sure the Robot is in **Rest**, **Stand** or **Walk** operational modes.

> **Notice**
>
> The payload is powered only in the **Rest**, **Stand** or **Walk** operational modes.

3. Call the ROS service ***/inspection_payload/go_idle*** to go out of position control.
4. Move the axis manually to the new position you want to have as the zero position.
5. Call the ROS service ***/inspection_payload/calibration_set_zero***.
6. Reactivate the axes control by calling the ROS service ***/inspection_payload/go_closed_loop***.

10.10 Send the Robot to ANYbotics for maintenance and repairs

When you send the robot to ANYbotics for maintenance or repairs, you must send the SSH keys allowing maintainer access as well. Make sure to use a secure channel, for example, store the SSH keys on a USB stick and send it separately to the Robot.

► *For more information, see "5.7 Change the Robot password and configure maintainer access" on page 119*

11 DECOMMISSIONING, DISASSEMBLY AND DISPOSAL

After the service life of the Robot is reached, the Robot must be disposed of in an environmentally appropriate manner.

- Batteries and electronics must be recycled according to local regulations.
- Metal can be scrapped, otherwise recycled according to local regulations.

12 SPECIFICATIONS

The specifications provide the limits of your Robot and supporting systems.

Ensure you are aware of these specifications and use your Robot within specified ranges.

12.1 Robot environmental specifications

Table 46 - Robot environmental specifications

Ambient temperature range	0 °C to 40 °C (continuous)
Humidity	5% to 95% relative humidity, non-condensing
Altitude	up to 2000 meters above sea level
EMC/EMI	Industrial environment (according to EN 61000-6-2 and EN 61000-6-4)
Ingress protection rating	IP67
Minimum narrow passage width	800 mm
Minimum turning area L x W x H	1000 x 1000 x 700 mm

12.2 Robot

Table 47 - Robot specifications

Size lying L x W x H	942 x 663 x 450 mm
Size standing L x W x H	886 x 540 x 908 mm
Weight	■ Including docking socket, no battery - 45.0 kg ■ Including docking socket and battery, no remote control transceiver - 50.6 kg ■ Including docking socket, battery, inspection payload, no remote control transceiver - 56.3 kg
Maximum payload	■ 10 kg under normal operating conditions ■ 15 kg with reduced performance Operating with a heavy inspection payload can reduce the maneuverability and walking time of the Robot.
Maximum walking speed	1.3 m/s

12.3 Computer specifications

Table 48 - Locomotion computer specifications

Processor	Intel core i7 8850H, 6 cores, 12 threads
Memory	2 x 8 GB 2666 MHz DDR4
Storage	240 GB SATA III SSD

Table 49 - Navigation computer specifications

Processor	Intel core i7 8850H, 6 cores, 12 threads
Memory	2 x 8 GB 2666 MHz DDR4
Storage	240 GB SATA III SSD

12.4 Router

Table 50 - Router specifications

Supported Wi-Fi Interfaces	IEEE 802.11 b/g/n 2x2 MIMO 2.4 GHz 20/40 MHz 64 QAM IEEE 802.11 a/n/ac 2x2 MU-MIMO 5 GHz 20/40/80 MHz 256 QAM

12.5 4G/LTE Cellular module

Table 51 - 4G/LTE cellular module specifications

LTE category	Cat-12
Peak download rate	< 600 Mbps
Peak upload rate	< 150 Mbps
LTE in unlicensed spectrum	LTE-LAA, CBRS band supported
4G/LTE frequency bands	B1, B2, B3, B4, B5, B7, B8, B9, B12, B13, B18, B19, B20, B26, B28, B29, B30, B32, B41, B42, B43, B46, B48, B66
3G frequency bands	B1, B2, B3, B4, B5, B6, B8, B9, B19

12.6 LIDAR unit

Table 52 - LIDAR unit specifications

Model	Velodyne VLP16 Puck
Number of Channels	16
Range Accuracy (typical)	up to ±30 mm
Measurement Range	0 to 100 m
Horizontal Field of View	360°
Vertical Field of View	–15° to 15° (30°)
Rotation Rate	5 Hz to 20 Hz
Laser Product Classification	Class 1 Eye-safe per IEC 60825-1:2007 & 2014
Laser Wavelength	903 nm

12.7 Battery

Table 53 - battery specifications

Dimensions L x W x H	466 x 136 x 78.1 mm
Weight	5.55 kg
Ingress Protection Rating	IP67
Battery Energy	907.2 Wh
Nominal Battery Voltage	43.2 V
Battery Operating Voltage	31.2 V to 50.4 V
Operating Temperature Range	0 °C to 40 °C
Time from Empty to Full Charge (with 8 A)	3 h (full charge) 2 h (70% quick charge)

12.8 Battery charger

Table 54 - Battery charger specifications

Dimensions L x W x H	178 x 358 x 128 mm
Weight	3.8 kg
Input Voltage (Alternating Current)	110 to 240 V / 50 to 60 Hz
Maximum Input Power	500 W
Output Voltage Range	30 V to 50.4 V
Output Current Range	8 A
Ingress Protection Rating	IP65

12.9 Battery charging adapter

Table 55 - Battery charging adapter specifications

Dimensions L x W x H	116 x 66 x 91.5 mm
Weight	350 g
Ingress Protection Rating	IP67

12.10 Docking station

Table 56 - Docking station specifications

Dimensions L x W x H	317 x 317 x 105 mm
Docking Station Weight	1.4 kg
Ingress Protection Rating	IP65
Mechanical interface	4 x 6.6 mm holes 92 mm square hole pattern

12.11 Inspection payload

Table 57 - inspection payload specifications

Dimensions	229 x 177 x 246 mm
Weight	5.7 kg
Ingress Protection Rating	IP67
Pan Unit Rotation Range	±165°
Tilt Unit Rotation Range	−90° to +180°

Table 58 - Thermal camera specifications

Resolution	336 x 256 pixels
Temperature Ranges	−40 °C to +550 °C (radiometry)
Field of View (horizontal)	46.0°

Table 59 - Zoom camera specifications

Resolution	Default: 1080 x 1920 p (FullHD), 15 FPS Maximum: 2160 x 3840 p (QFHD/4k), 30 FPS
Optical Zoom Ratio	20x
Field of View Tele (horizontal)	4.1°
Field of View Wide Angle (horizontal)	70.2°

Table 60 - Microphone specifications

Sampling Rate	384 kHz
Resolution	16 bit

Table 61 - Spotlight specifications

Maximum Luminous Flux	1895 lumen (continuous) 3790 lumen (short periods)
Beam Angle	60°
Dimmable	Software controlled

12.12 Transport Box specifications

Table 62 - Transport Box specifications

Dimensions L x W x H	1180 x 760 x 930 mm
Weight Empty	ca. 60 kg

12.13 Robot emergency stop

Table 63 - Robot emergency stop specifications

Classification	ISO 13849-1:2015 Category 3 PL c
Response Time	<0.2 s
Muting	Not possible
Control Modes	Always active
Test Interval	1 year

12.14 Delayed start with warning

Table 64 - Delayed start with warning specifications

Classification	ISO 13849-1:2015 Category 3 PL c
Response Time	<0.1 s
Muting	Not possible
Delay Period	≥9 s
Control Modes	On actuators power up
Test Interval	1 year

12.15 Danger zone active warning light

Table 65 - Danger zone active warning light specifications

Classification	ISO 13849-1:2015 Category 3 PL c
Response Time	<0.1 s
Muting	Not possible
Control Modes	Always active
Test Interval	1 year

12.16 Pin-outs of connectors

Notice

Exceeding current limits of connectors can damage the Robot.

Before connecting external devices to the Robot, contact our customer service at info@anybotics.com or https://support.anybotics.com/request/

The following sections provide details of the pin-out connections for the connectors located on top of the robot.

► *For more information, see "2.3.2 Connections" on page 54*

12.16.1 Ethernet port

Warning

An external device can be connected to the ethernet port with the Robot turned on.

Shut down the Robot before connecting a device to the Ethernet port.

Warning

Make sure the polarity of the connected device and the ethernet port are correct before making a connection.

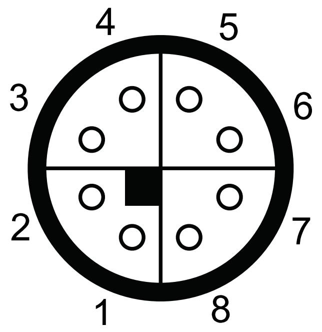
Make sure there is no short-circuit between the device connector and the ethernet port. A short circuit will disable the ethernet port.

If a short-circuit happens, remove the device connector and restart the Robot.

► *For more information, see "4.5 Shut down the system" on page 107*

Table 66 - External specifications of the Ethernet port

Function	Ethernet 1000BASE-T
Connection	Connected to the internal LAN of the Robot.
Receptacle type	M12 female X-coded (IEC 61076-2-109)
Receptacle P/N	NorComp 859-X08-203R0R4
Receptacle protection cap (recommended)	Phoenix Contact 1456200
Plug type	Side A: M12 male X-coded Side B: RJ45 male Max. length of the cable: 30 m (CAT5e or better)
Plug P/N (recommended)	Murrelektronik 7000-51101-7900500 (5 m) METZ CONNECT 142M2X15050 (5 m)



Pin	Signal	Description	Pin	Signal	Description
1	MX1+	Ethernet pair 1+	5	MX4+	Ethernet pair 4+
2	MX1–	Ethernet pair 1–	6	MX4–	Ethernet pair 4–
3	MX2+	Ethernet pair 2+	7	MX3–	Ethernet pair 3–
4	MX2–	Ethernet pair 2–	8	MX3+	Ethernet pair 3+

Figure 72 - Ethernet port pin-out connectors

12.16.2 USB Type-C port

Warning

Do not supply power to the USB Type-C port. The USB Type-C port must only be used as a power source.

Do not connect an external device to the USB type-C port with the Robot turned on.

Shut down the Robot before connecting a device to the USB type-C port.

▶ *For more information, see "4.5 Shut down the system" on page 107*

Notice

Before connecting a device to the USB Type-C port, make sure it complies with the *USB 3.2* specification.

- *USB 3.2 SuperSpeed* operation is only supported in one plug orientation.
- *USB 2.0* operation is supported in both plug orientations.

If a *USB 3.2 SuperSpeed* connection can not be made, rotate the USB Type-C connector 180° and restart the Robot.

> **Notice**
> The 5 V bus power current must not be more than 1.5 A.

Table 67 - External specifications of the USB Type-C port

Function	Compatible with USB Type-C (USB 3.2 Gen 1x1)
Connection	Connected to the NPC.
Receptacle type	USB Type-C receptacle, IP67
Receptacle P/N	ES&S STE-IP67-USB-C-F-USB-C-F-PANEL-M12
Receptacle protection cap (recommended)	Included in the receptacle P/N
Plug type	USB Type-C plug
Plug P/N (recommended)	We recommend using a certified USB Type-C cable and connector according to the *USB Type-C Cable and Connector Specification*. IP67 option: ES&S KAB-IP67-VM-USB-C-M-USB-C-M-1000RK-M12 (1 m)

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GRD	TX1+	TX1-	VBUS	CC1	D+	D-	SBU1	VBUS	RX2-	RX2+	GRD
GRD	RX1+	RX1-	VBUS	SBU2	D-	D+	CC2	VBUS	TX2-	TX2+	GRD
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Pin	Signal	Description	Pin	Signal	Description
A1	GND	Ground return	B12	GND	Ground return
A2	TX1+	Positive half of first TX differential pair	B11	RX1+	Positive half of first RX differential pair
A3	TX1–	Negative half of first TX differential pair	B10	RX1–	Negative half of first RX differential pair
A4	VBUS	5 V bus power	B9	VBUS	5 V bus power
A5	CC1	Configuration channel	B8	SBU2	Sideband use
A6	D1+	Positive half of USB 2.0 differential pair	B7	D2–	Negative half of USB 2.0 differential pair
A7	D1–	Negative half of USB 2.0 differential pair	B6	D2+	Positive half of USB 2.0 differential pair
A8	SBU1	Sideband use	B5	CC2	Configuration channel
A9	VBUS	5 V bus power	B4	VBUS	5 V bus power

Pin	Signal	Description	Pin	Signal	Description
A10	RX2–	Negative half of second RX differential pair	B3	TX2–	Negative half of second TX differential pair
A11	RX2+	Positive half of second RX differential pair	B2	TX2+	Positive half of second TX differential pair
A12	GND	Ground return	B1	GND	Ground return

Figure 73 - USB port pin-out connectors

12.16.3 RS-232 port

Warning

Do not supply power to the RS-232 port. The RS-232 port must only be used as a power source.

Do not connect an external device to the RS-232 port with the Robot turned on.

Shut down the Robot before connecting a device to the RS-232 port.

- *For more information, see "4.5 Shut down the system" on page 107*

Warning

Make sure the polarity of the connected device and the RS-232 port are correct before making a connection.

Make sure there is no short-circuit between the device connector and the RS-232 port. A short circuit will disable the RS-232 port.

If a short-circuit happens, remove the device connector and restart the Robot.

- *For more information, see "4.5 Shut down the system" on page 107*

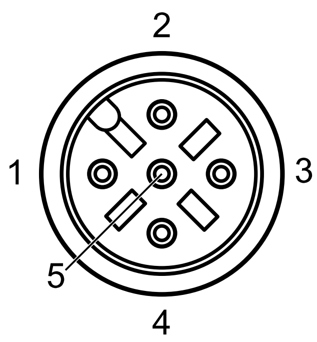
Notice

Make sure that the serial bus electrical specifications of the connected device match the input and output specifications of the RS-232 port.

> **Notice**
>
> The maximum current and capacitive load on the RS-232 port is shared with the RS-485 port.
>
> - The 12 V bus power current must not be more than 1 A.
> - The maximum capacitive load must not be more than 30 µF.

Table 68 - External specifications of the RS-232 port

Function	Serial RS-232 (UART) with 12 V auxiliary power
Connection	Connected to the NPC.
Receptacle type	M12 female A-coded 5P (IEC 61076-2-101)
Receptacle P/N	Escha 8077906
Receptacle protection cap (recommended)	NorComp 858203M-DC
Plug type	Side A: M12 male A-coded 5P Side B: The type is defined by the customer and is application specific.
Plug P/N (recommended)	Escha 8045559 (2 m, straight, shielded, open end) Escha 8045560 (2 m, right-angled, shielded, open end)



Pin	Signal	Description	Pin	Signal	Description
1	12 V	12 V bus power	4	TX	TXD
2	PGND	Power ground	5	DGND	Digital ground for zero voltage reference
3	RX	RXD			

Figure 74 - RS-232 port pin-out connectors

12.16.4 RS-485 port

Warning

Do not supply power to the RS-485 port. The RS-485 port must only be used as a power source.

Do not connect an external device to the RS-485 port with the Robot turned on.

Shut down the Robot before connecting a device to the RS-485 port.

▶ *For more information, see "4.5 Shut down the system" on page 107*

Warning

Make sure the polarity of the connected device and theRS-485 port are correct before making a connection.

Make sure there is no short-circuit between the device connector and the RS-485 port. A short circuit will disable the RS-485 port.

If a short-circuit happens, remove the device connector and restart the Robot.

▶ *For more information, see "4.5 Shut down the system" on page 107*

Notice

Make sure that the serial bus electrical specifications of the connected device match the input and output specifications of the RS-485 port.

Notice

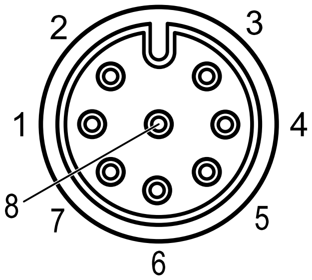
The maximum current and capacitive load on the RS-485 port is shared with the RS-232 port.

- The 12 V bus power current must not be more than 1 A.
- The maximum capacitive load must not be more than 30 μF.

Table 69 - External specifications of the RS-485 port

Function	Serial RS-485 (UART) with 12 V auxiliary power
Connection	Connected to the NPC.
Receptacle type	M12 female A-coded 5P (IEC 61076-2-101)
Receptacle P/N	Escha 8077911

Receptacle protection cap (recommended)	NorComp 858203M-DC
Plug type	Side A: M12 male A-coded 8P Side B: The type is defined by the customer and is application specific.
Plug P/N (recommended)	Escha 8046807 (2 m, straight, shielded, open end) Escha 8046998(2 m, right-angled, shielded, open end)



Pin	Signal	Description	Pin	Signal	Description
1	12 V	12 V bus power	5	TX–	TXD-
2	PGND	Power ground	6	RX–	RXD-
3	RX+	RXD+	7	—	Not used
4	TX+	TXD+	8	—	Not used

Figure 75 - RS-485 port pin-out connectors

12.16.5 Power port

Warning

Do not supply power to the power port. The power port must only be used as a power source.

Do not connect an external device to the power port with the Robot turned on.

Shut down the Robot before connecting a device to the power port.

► *For more information, see "4.5 Shut down the system" on page 107*

Warning

Make sure the polarity of the connected device and the power port are correct before making a connection.

Make sure there is no short-circuit between the device connector and the power port. A short circuit will disable the power port.

If a short-circuit happens, remove the device connector and restart the Robot.

▶ *For more information, see "4.5 Shut down the system" on page 107*

Notice

The 12 V bus power (pin 4) can be enabled and disabled using ROS service calls:

- To enable: `rosservice call /pdb_driver/set_power_line 13`
- To disable: `rosservice call /pdb_driver/set_power_line 13 0`

The unregulated battery power bus (pins 1 and 2) can be enabled and disabled using ROS service calls:

- To enable: `rosservice call /pdb_driver/set_power_line 5 1`
- To disable: `rosservice call /pdb_driver/set_power_line 5 0`

Make sure that the unregulated battery power bus (pins 1 and 2) is not enabled before the actuator voltage is enabled. The unregulated battery power bus can only be enabled if the actuators are turned on.

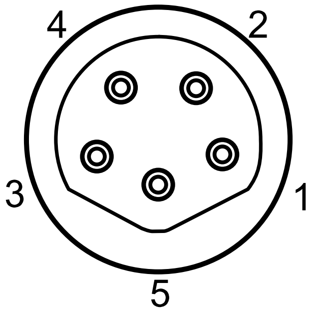
Notice

The maximum current and capacitive load on the power port must not be more than the following specifications.

- The unregulated battery power bus current must not be more than 3.4 A.
- The 12 V bus power current must not be more than 3.4 A.
- The maximum capacitive load must not be more than 1000 µF.

Table 70 - External specifications of the power port

Function	Additional power and external trigger
Receptacle type	M8 female B-coded 5P (IEC 61076-2-104)
Receptacle P/N	Binder 76 6618 1111 00005-0200
Receptacle protection cap (recommended)	Binder 08 2973 000 000
Plug type	Side A: M8 male B-coded 5P Side B: The type is defined by the customer and is application specific.
Plug P/N (recommended)	Binder 77 3403 0000 50005-020 (2 m, right-angled, unshielded, open end)



Pin	Signal	Description	Pin	Signal	Description
1	+BATT	Unregulated battery power bus positive	4	12 V	12 V bus power
2	−BATT	Unregulated battery power bus negative	5	PGND	Power ground
3	TRIG	External trigger out referenced to PGND			

Figure 76 - Power port pin-out connectors

12.17 Handles

Table 71 - specifications

Maximum load per handle	180 kg per handle

13 REGULATORY AND COMPLIANCE INFORMATION

13.1 EC Declaration of conformity

This Declaration of Conformity is issued under the sole responsibility of the manufacturer.

Manufacturer

ANYbotics AG
Hagenholzstrasse 83a
8050 Zurich
Switzerland
https://www.anybotics.com

Description of the machinery

Products in the scope of the Declaration of Conformity:

- ANYmalRobot (P/N: AM-D100-A)

The ANYmalRobot is only to be used with the following accessories:

- Battery charger (P/N: C-BC-D-A)
- Docking station (P/N: C-DST-D-A)
- Battery (P/N: BAT-D-A)
- Battery charging accessories:
  - Charging cable (P/N: C-CC-D-A)
  - Battery charging adapter (P/N: C-BCA-D-A)
- Inspection payload (P/N: P-PTU-D-A)
- Transport Box (P/N: TS-TB-D-A)

Declaration

The listed products fulfill all the relevant provisions of the following directives:

- Machinery Directive 2006/42/EC (MD) and amended. The harmonized standards used for Presumption of Conformity to the MD, as referred to in Art. 7(2) of MD are: ISO 12100:2010, EN 60204-1:2018.

- EMC Directive 2014/30/EU (EMCD) and amended. The harmonized standards used for Presumption of Conformity to the EMCD, as referred to in Art. 13 of the EMCD are: EN 61000-6-2, EN 61000-6-4, EN 61000-6-7.
- Radio Equipment Directive 2014/53/EU (RED) and amended. The harmonized standards used for Presumption of Conformity with the RED, as referred to in Art. 16 of the RED are: ETSI EN 301 489-1 V1.9.2/V2.2.3, ETSI EN 301 489-6 V2.2.1, ETSI EN 301 489-17 V3.2.2, ETSI EN 300 328 V2.1.1, ETSI EN 301 893 V2.2.1 and ETSI EN 301 406 V2.2.2.
- Low Voltage Directive (LVD) 2006/95/EC and amended, as required by Article 3.1.a of the RED . The harmonized standard used for Presumption of Conformity to the LVD, as referred to in Art. 12 is: EN 60204-1:2018
- Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU and amendments 2017/2012.

Other Technical Standards that are used for design requirements are ISO 14118:2018, ISO 61508-1:2010, ISO 13850:2015, ISO 13849-1:2015, ISO 13849-2:2012, EN 62368-1:2020+A11:2020 and EN 62133-2:2017

Name of the person authorized to compile the technical file:	Dr. Michael M. Antivachis Senior certification manager

Signatures

Zurich	16/12/2021		
Place of issue	Date of issue	Dr. Mario Mauerer CTO hardware	Dr. Christian Gehring Senior director of robotics

13.2 International standards

ANATEL

Incorpora produto homologado pela Anatel sob número 01333-22-14562.

Incorpora produto homologado pela Anatel sob número 05352-21-03436.

14 INDEX

R