Leo Rover specification

▸ Specifications for previous versions of the Leo Rover

Introduction

Leo Rover is a compact, 4-wheeled, remote-controlled robot designed for indoor and outdoor robotic project development, learning, and research applications. It is equipped with a built-in computer, a high-resolution camera, and a powerful battery, making it suitable for various tasks, including autonomous navigation, obstacle detection, and remote monitoring.

Main parameters

Parameter	Value
Dimensions (LxWxH)	424 mm x 445 mm x 303 mm
Weight	≈ 7 kg

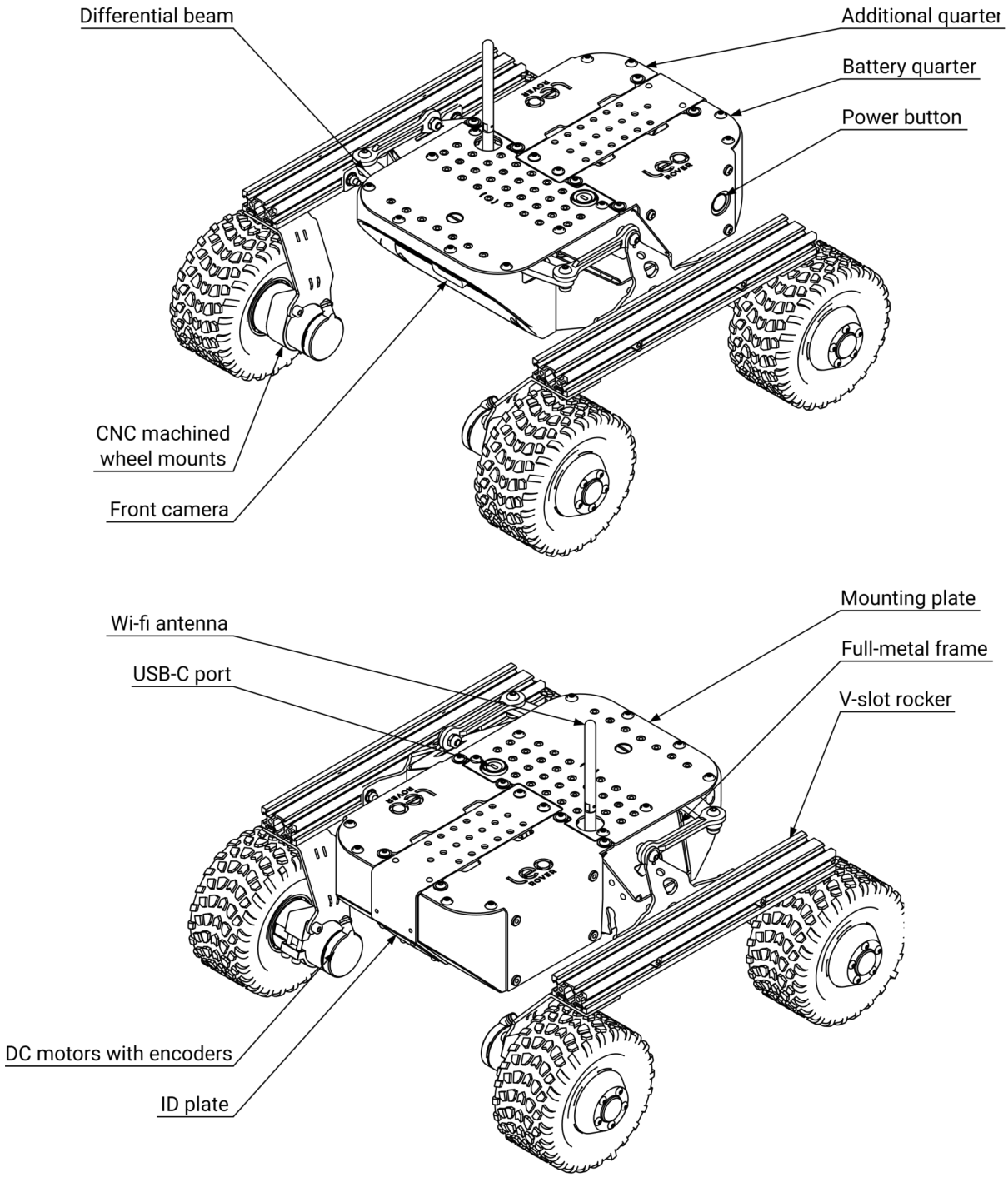
Parameter	Value
Maximum payload	≈ 5 kg*
Maximum linear speed	≈ 0.4 m/s
Maximum angular speed	≈ 1 Rad/s
Estimated max. obstacle size	≈ 70 mm
IP protection rating	IP 55
Operating temperature	-10 °C to +40 °C
Run time	up to 4 hours with standard battery
Connection range	Up to 100 m

* - on standard tires

Traction parameters

Parameter	Value
Track Width	354 mm
Wheelbase length	295 mm
Ground clearance	108 mm
Climb grade (no payload)	45° (100 %)
Climb grade with 5kg payload	45° (100 %)
Hill grade traversal	45° (100 %)
Nominal torque	4 Nm
Maximum torque	5.6 Nm

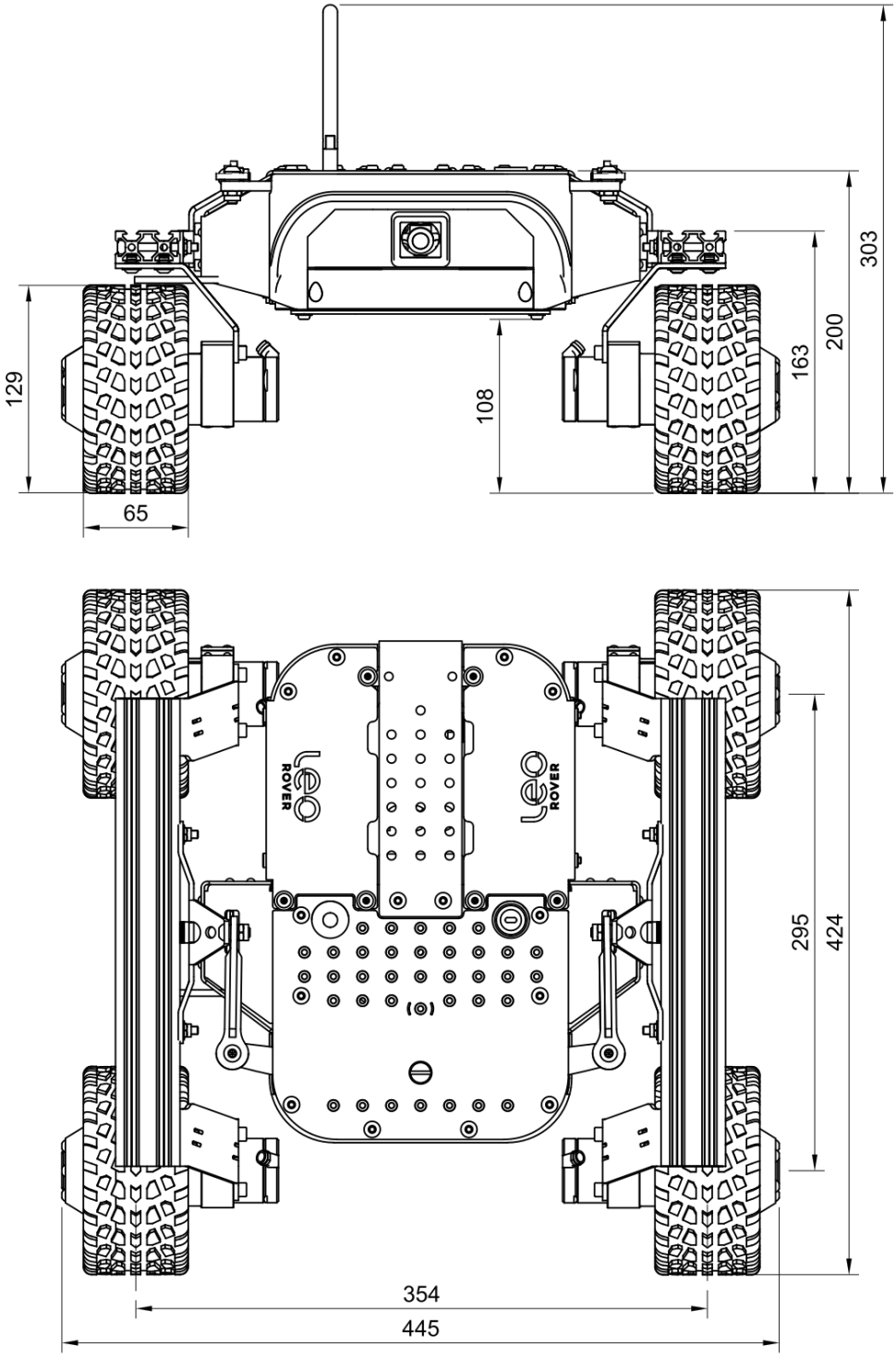
Rover overview



Leo Rover overview

Hardware specification

Dimensions

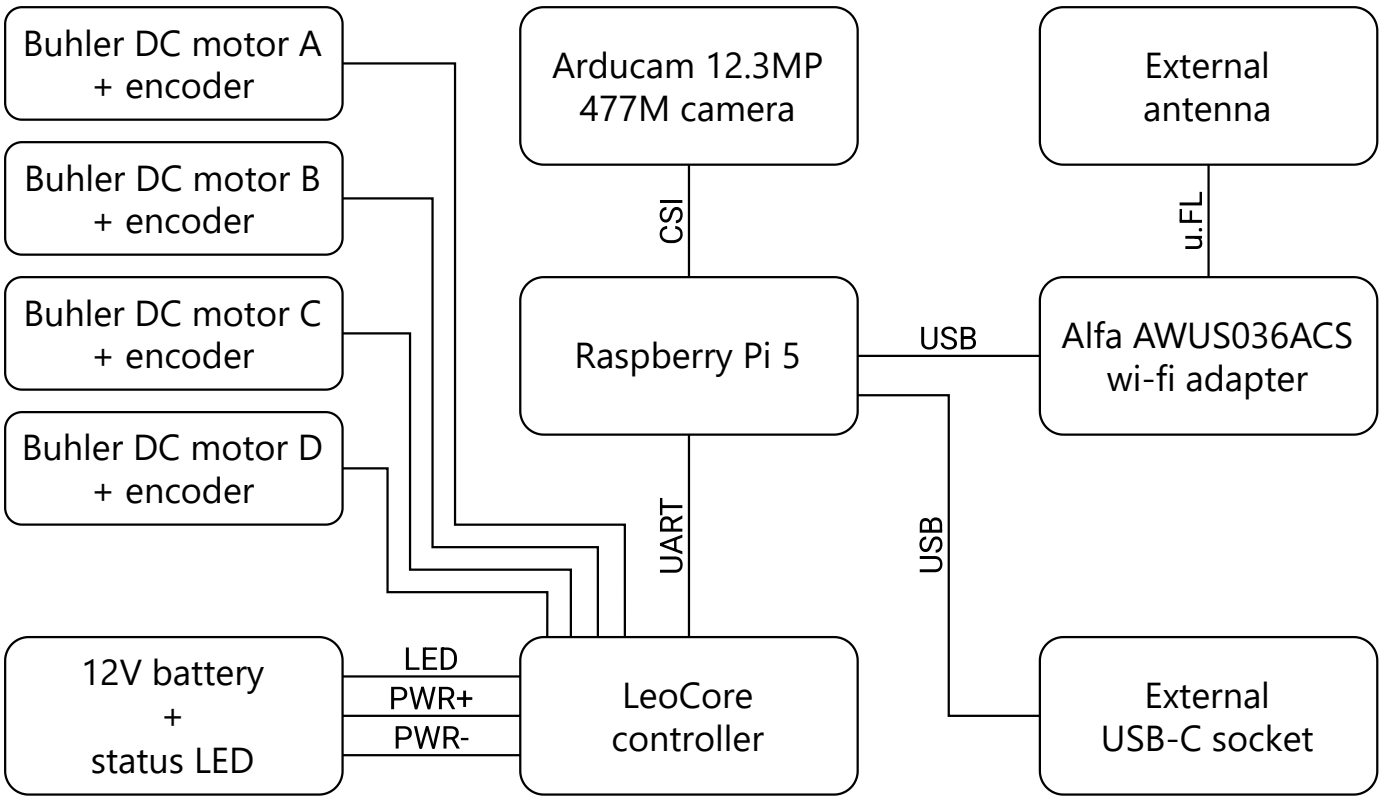


Dimensions of Leo Rover

Components

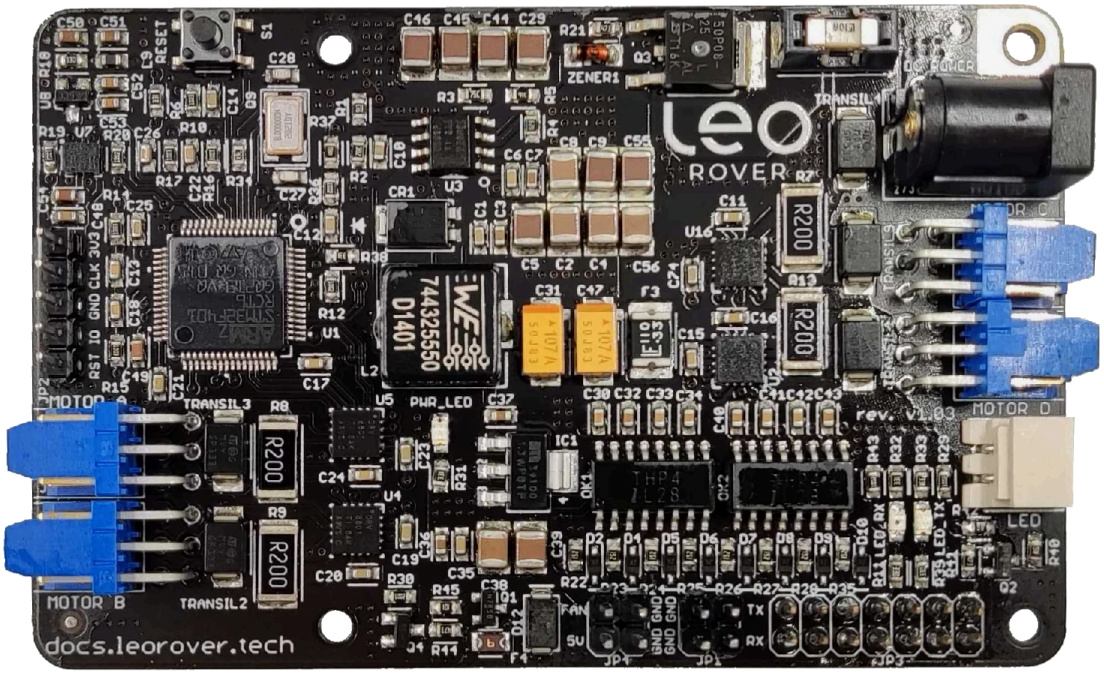
Name	Quantity	Description
Built-in computer	1	Raspberry Pi 5 - A single-board computer developed by Raspberry Pi Ltd. Key features: • Processor: Broadcom BCM2712, 2.4GHz quad-core 64-bit Arm Cortex-A76 CPU with cryptography extensions. • Memory: 4GB LPDDR4X-4267 SDRAM. • Storage: Micro SD card slot with support for high-speed SDR104 mode; PCIe 2.0 x1 interface for fast peripherals (requires separate M.2 HAT or adapter). • Connectivity: ◦ Gigabit Ethernet (supports PoE+ with separate PoE+ HAT) ◦ Dual-band 802.11ac Wi-Fi ◦ Bluetooth 5.0 / Bluetooth Low Energy (BLE) ◦ 2 x USB 3.0 ports supporting simultaneous 5Gbps operation ◦ 2 x USB 2.0 5 ports ◦ 2 x micro-HDMI ports supporting resolutions up to 4kp60 with HDR support ◦ 2 x 4-lane MIPI camera/display transceivers ◦ standard 40-pin GPIO header
Wi-Fi adapter	1	Alfa AWUS036ACS: USB 2.0 Wi-Fi adapter (Realtek RTL8811AU). Dual-band 802.11ac (AC600: 150 Mbps 2.4GHz + 433 Mbps 5GHz).
Antenna	1	Dual-band (2.4 GHz / 5 GHz) placed on the top of the robot.
Front camera	1	Arducam 12.3MP 477M HQ Camera Module for Raspberry Pi with 158°(D) M12 Wide Angle Lens.
DC motors	4	Bühler Motors 1.61.077.414 connected to LeoCore.

Block diagram



LeoCore controller

Leo Rover since version 1.8 is based on the LeoCore electronics board which, together with the Raspberry Pi computer, controls all the Rover's functionalities.



To make it easier, we listed all the interfaces used by Leo Rover as default. Just to make sure you don't interfere with them when developing.

Port	Functionality
Power input	to power the board
RPi port	to power and RPi serial communication
LED output	to control the battery LED (to show system readiness)
Motor output A, B, C & D (PWM H-bridge)	to power the rover motors and encodes
5-pin debug port	used to flash firmware to the board using ST-link/V2 (optionally)

Drivetrain

The standard configuration of the Leo Rover features a drivetrain comprising four fixed wheels. This design enhances the mobility of the Rover, enabling it to execute precise maneuvers such as:

- turning in place (around center of mass of the rover)
- turning around a curve

In addition, Leo Rover has a differential suspension system, which allows it to traverse uneven terrain and obstacles. The suspension system is designed to provide a smooth ride and maintain stability while driving over rough surfaces.

Motors

The Rover is equipped with four in-hub DC motors, each featuring a planetary gearbox with a gear ratio of 73.2:1. This configuration allows for precise control of the Rover's movement and enables it to navigate various terrains with ease. The motors are equipped with encoders that provide feedback on the wheel's position and speed, allowing for accurate control of the Rover's movement.

Wheels

As standard, Leo Rover comes with rubber tires with a diameter of about 130 mm. Whole drive assembly has following characteristics:

Parameter	Value
Tire size (diameter x thickness)	≈ 125 mm x ≈ 70 mm
Tire lock type	non beadlock
Tire insert	soft foam (non pneumatic)
Wheel rim diameter	98 mm

Battery & charging

Leo Rover is powered by a 3S Li-Ion battery with a capacity of 7000 mAh. The battery is equipped with an internal battery management system (BMS) that provides protection against overcharging, over-discharging, and short circuits. The battery is designed to be easily replaceable, allowing for quick swaps during extended use.

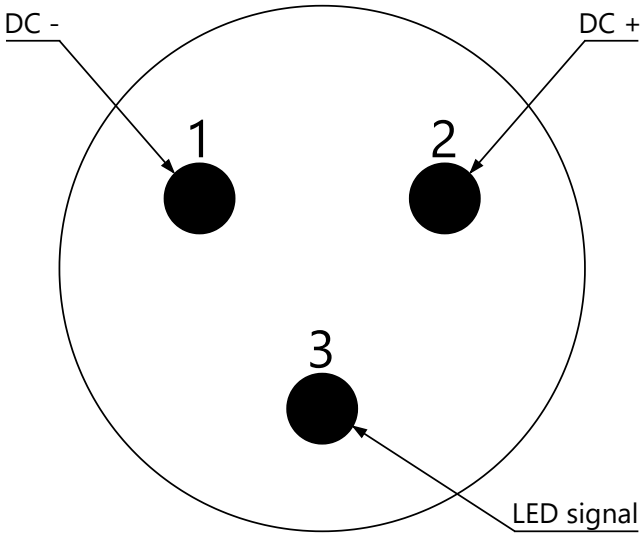
Each battery pack has following characteristics:

Parameter	Value
Voltage	11.1 V (nominal)
Battery type	Li-Ion
Battery cell	18650 (Samsung INR18650-35E)
Capacity	7 Ah (84,7 Wh - flight safe)
Battery pack type	3S2P
Maximum output power	≈ 120 W
Safety systems	Overcurrent, Reverse polarity protection

Connectors

By default Leo Rover uses standard WEIPU SP13-3 connectors for connecting battery, Main Electronics Box and other possible addons.

Pin name	Cable color
DC-	black
DC+	red / black with white stripe
LED	green



Battery charger

The Rover is equipped with a 2A 12.6V Li-Ion battery charger that can charge the standard battery in approximately 4 hours. The charger is designed to be compact and portable, making it easy to transport and use in various environments. The charger is equipped with a standard 5.5/2.1 mm DC plug.

The charger is outfitted with an LED status indicator designed to provide information about the charging status of the battery. A green LED signifies that the battery has reached full charge, while a red LED indicates that the battery is currently in the charging process.

Parameter	Value
Voltage	12.6 V
Current	2 A (max)
Charger type	Li-Ion
Charger plug	DC 5.5/2.1 mm (center positive)
Charger adapter	Weipu SP13-3 - DC 5.5/2.1 mm

To connect the charger to the battery, a Weipu SP13-3 - DC 5.5/2.1 mm adapter is included with each Rover. This adapter allows for easy and secure connection between the charger and the

battery, ensuring that the charging process is efficient and safe.

For more information on how to charge the battery, please refer to the Leo Rover Getting started guide:

Getting started
Leo Rover Setup: Quick guide on connecting, operating, and charging Leo Rover for optimal performance and longevity.

Payload specification

Leo Rover is designed to be modular and customizable, allowing users to attach various payloads and accessories to the Rover. The Rover features a mounting platform on the top, which can accommodate different payloads and accessories. The payload capacity of the Rover is approximately 5 kg, making it suitable for a wide range of applications, including research, education, and development.

Parameter	Value
Payload capacity	≈ 5 kg
Hole grid spacing	18 mm x 15 mm
Mounting hole dimensions	7 mm, equipped with T-KFS-M4-1 press-in nuts
Main mounting plate dimensions (L x W x D)	299 mm x 183 mm x 2 mm

Apart from the mounting plate, it is possible to mount payloads directly to v-slot extrusions of the Leo Rover.

In order to power the payload, we recommend purchasing a Powerbox module which replaces the additional quarter of the rover.

Powerbox

The Powerbox module significantly enhances Leo Rover's capabilities by providing versatile power options and enabling continuous operation through battery hot-

swaps and external power access.

Software specification

Rapha Rover's software heavily relies on The Robot Operating System (ROS) which offers the robot the following functionalities:

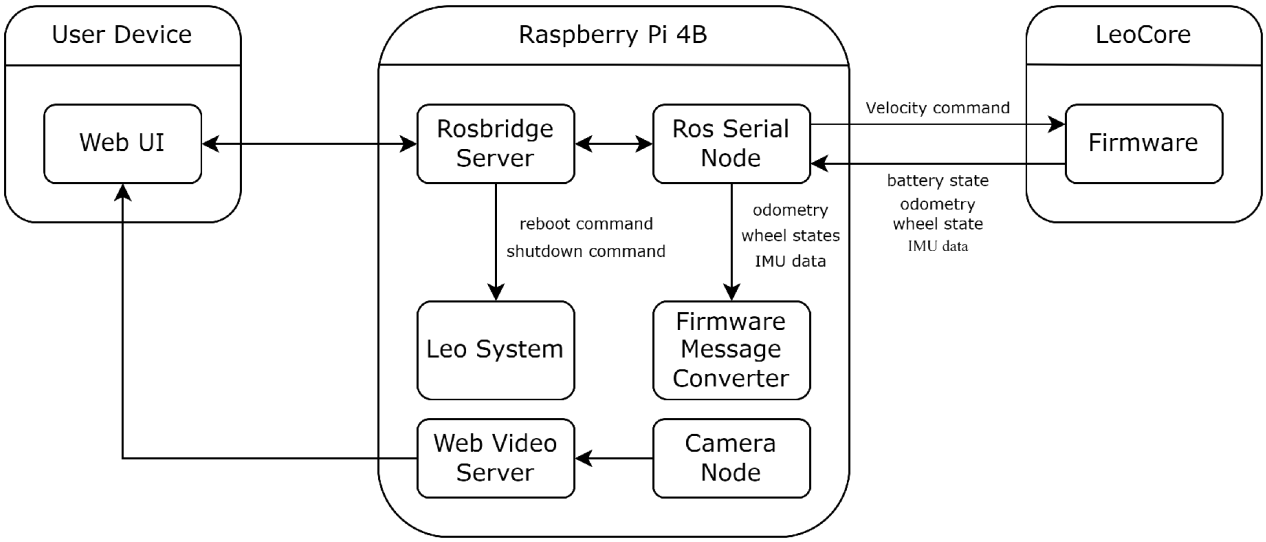
- Abstraction layer facilitating communication between software components.
- Open-source software components, maintained by the community.
- A collection of standard message interfaces.
- Tools for introspection.

The primary segment of the software stack is partitioned into several ROS Nodes, treated as computational units, each doing one logical thing. The nodes interact via:

- **Topics** - Named buses enabling message exchange between nodes. They are strongly typed and employ anonymous publish/subscribe semantics.
- **Services** - A client/server mechanism for remote procedure calls between nodes. The service server accepts remote procedure requests identified by name and type, which must be known to the service client beforehand.
- **Parameters** - Sets of key/value pairs maintained separately by each node, utilized for node configuration during startup and runtime without necessitating code modifications.
- **TF transforms** - A single transform describes the relationship between 2 coordinate frames at a specific point in time. TF transforms are distributed between nodes using topics, but, for the sake of clarity, we will refer to them as separate entities.

There are two important software components which don't run as native ROS nodes:

- **Controller firmware** - The firmware itself acts as a ROS node but uses eProsima's Micro XRCE-DDS as its middleware. Thus, it requires the presence of the Micro-ROS Agent on the built-in computer to communicate with other ROS nodes.
- **Web User Interface** - The WebUI establishes a connection with the Rosbridge Server via WebSocket transport layer and employs the rosbridge protocol for communication with the ROS nodes.



Firmware specification

This is the program that runs directly on the processor of the LeoCore board. It provides different functionalities to the Raspberry Pi through serial bus. The main features of the default leocore_firmware are:

- differential drive controller (cmd_vel interface)
- wheel states monitoring (joint_states interface)
- battery voltage monitoring
- wheel odometry calculation
- IMU support

Web user interface (UI)

This is the user interface that can be accessed via a web browser. It communicates with Rosbridge server using roslibjs to access functionalities that are available in ROS topics. The default leo_ui brings features such as:

- control of the Rover via a keyboard or a virtual joystick
- display of a camera stream from Web video server
- output of current battery voltage measurement
- reboot and shutdown buttons

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Last updated on ***May 14, 2025***