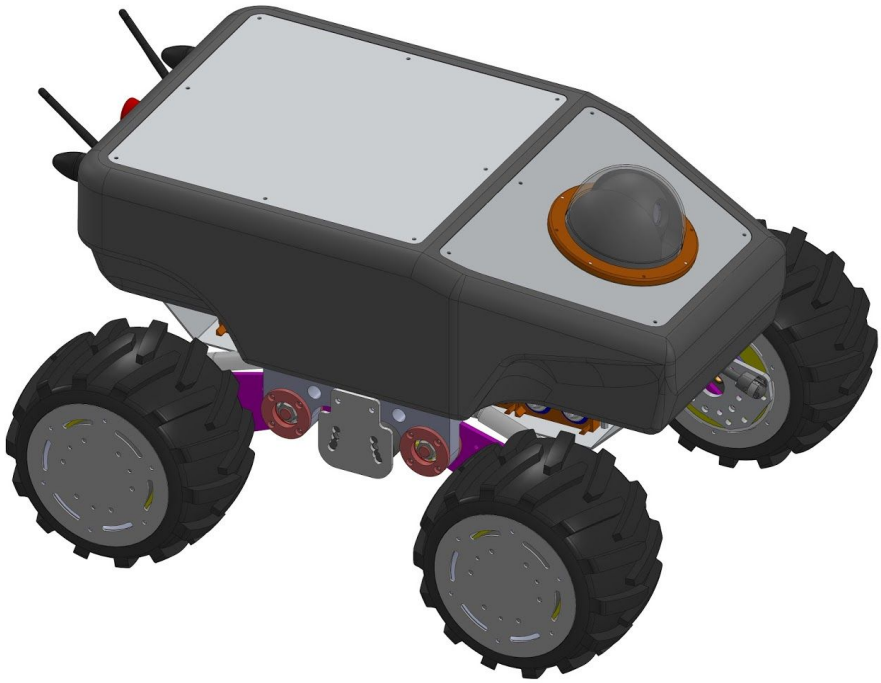
Robotnik

SUMMIT XL
MOBILE PLATFORM



SYSTEM ELEMENTS MAINTENANCE MANUAL

RBTNK-DOC-160609A
Robotnik Automation SLL, Spain

Contents

1. Introduction

This Manual describes the main parts of the SUMMIT XL mobile robot, as well as how are they assembled. Every main piece includes a little description of the mechanical component that composes it, emphasizing the elements that need a special periodical control and maintenance.

The location and maintenance of other non mechanical components is also described below.

Finally, a summary of the basic drawings of the vehicle and the main components has been included.

2. External Elements

The next figures show the main parts of the robot:

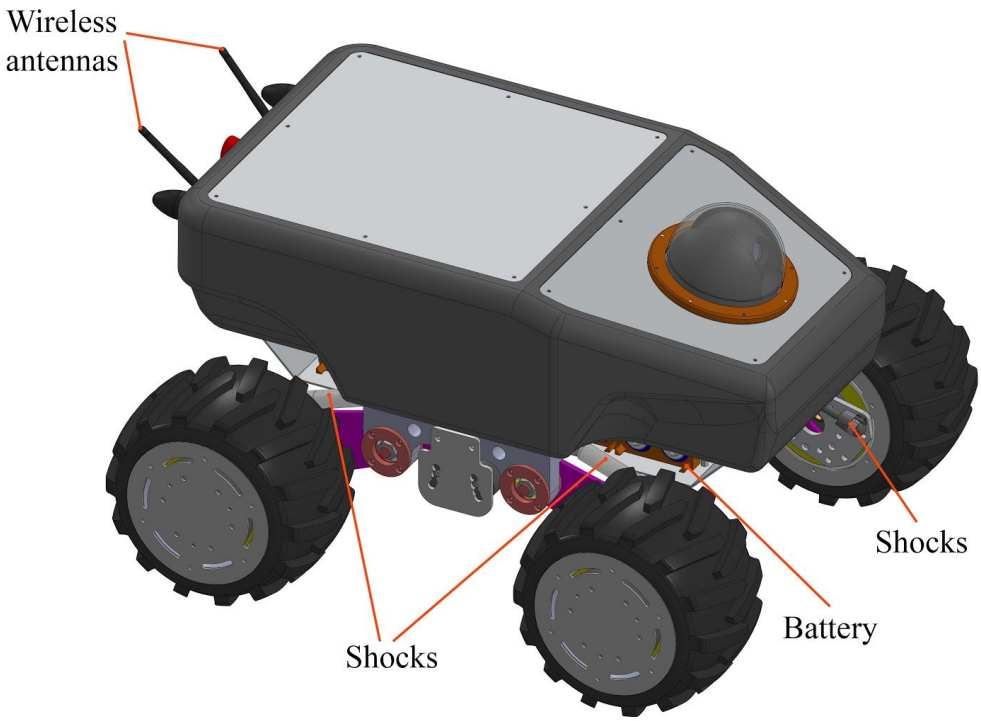


Figure 1 – Main parts of SUMMIT XL robot

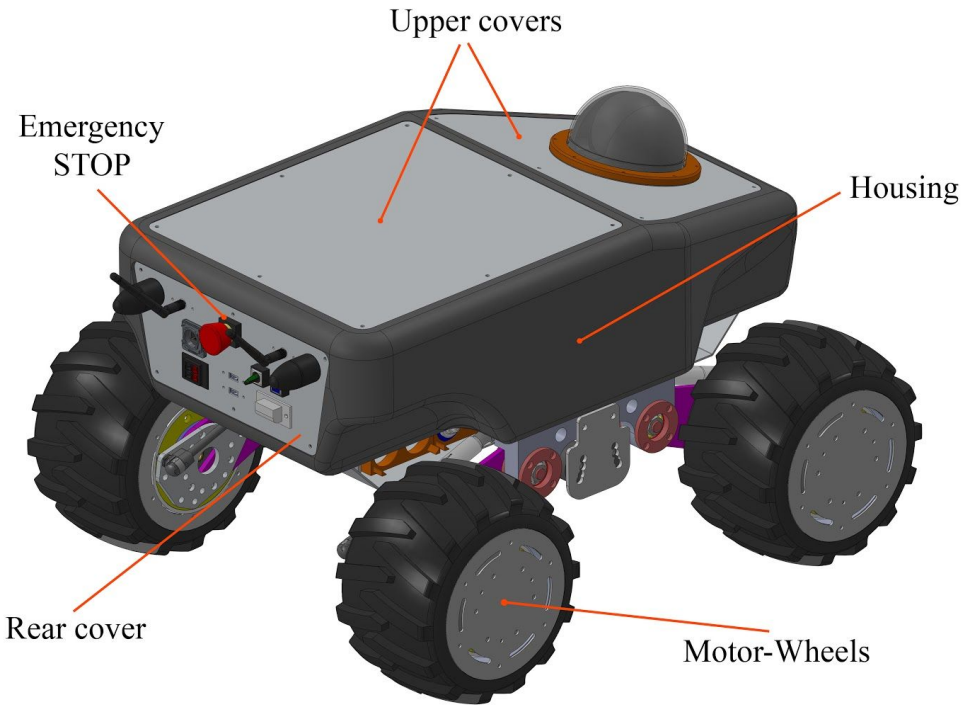


Figure 2 – Main parts of SUMMIT XL robot, rear view

The main parts that form the robot are:

- **Housing**: It is made of fiber glass and holds the upper and rear covers. The electrical components are placed inside. Only the battery is outside.
- **Upper Covers:** Can be removed to access to the interior of the robot where some of the control components like the control computer are placed.
- **Rear Cover:** Holds the control panel, buttons and the wireless antennas.
- **Motor wheels:** Four motor wheels 250W brushless motor with Hall Effect sensor and a reduction gear box inside the aluminum wheel.
- **Battery:** 24V LiFePO4 battery (8x3.2V 15Ah cells).
- **Shocks:** Four strong shock absorbers.
- *(optional) PTZ cameras* protected by replaceable domes and sensors.
- *Emergency Stop, Front and Rear Bumper disable the drivers stopping the robot if activated. Caution: there is no rearm button.*

2.1 Motor wheels

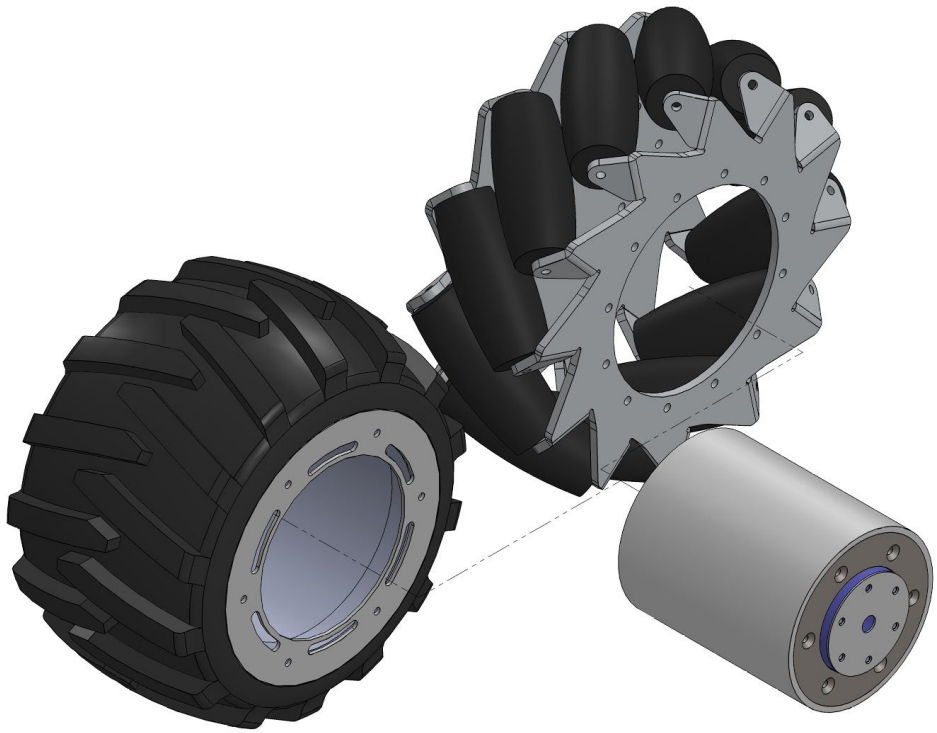


Figure 3 – Motor wheels

The robot has 4 motor wheels with the same configuration. Each wheel is composed by a motor block and a detachable wheel. The motor block has a 250W 8 poles brushless motor with Hall Effect sensor and a reduction gear box, all hold by an aluminum cover. These kinds of motors have a much longer life expectancy and a higher efficiency than brushed motors.

This kind of rubber tire is specially made for Robotnik, so contact us if you need to replace them. It has a width of 145mm and a diameter of 235mm. The motor block diameter is 100mm. It is recommended that no weight rests on the wheels for a very long time when stopped to avoid flattening.

The cable must be kept in good condition, and protected if the external cover is damaged. There are three 24V power wires, two 5VDC power and three Hall Effect signals. If they are short-circuit, the motor and the driver can be damaged.

2.2 Motor Drivers

Figure 4 – Motor Driver

The motor drivers are four DZCANTE 020L080 with a MC1DZC connection board on top.

The drivers are programmed at Robotnik with specific a settings for each motor. The serial identifier is the default one (63), but each driver has its own CAN bus identifier (1, 2, 3 and 4). DO NOT change them from one motor to another. To reduce power consumption, if the velocity is zero, only the rear wheels brake, the front ones are free.

The computer sends CAN messages to move the robot, and they are different from the left side (1 & 2) and right side (3 & 4). Driver 1 is the only one with the Can bus resistor installed.

There are several analog and digital input/outputs available in each driver, check driver datasheet for more information.

2.3 Control Panel

The robot presents in its back cover several buttons, indicators and connectors:

Figure 5 - Control panel

- EMERGENCY STOP will disable the drivers and stop the robot. CAUTION there is no rearm button, so the robot will keep moving when the Emergency Stop is released.
- General ON/OFF key (S1): cuts the power of the whole robot. It has a green light indicator.
- CPU POWER blue indicator/switch: turns on and off the computer
- 12 VDC: intended to power external devices and protected with fuse
- CHARGER: to connect the provided battery charger
- Two free USB 2.0 ports
- Ethernet port (by default a WAN port)
- Wi-Fi antennas

2.4 Axis Camera (optional)

Figure 6 – Axis PTZ camera

CAMERA	AXIS P5514 PTZ Dome Network Camera
Image sensor	1/2.3” progressive scan CMOS
Lens	3.8–42.9 mm, F1.4–2.1 Horizontal angle of view: 59.2°–5.2° Autofocus, Auto-iris
Minimum illumination	Color: 0.7 lux at 30 IRE F1.4 B/W: 0.08 lux at 30 IRE F1.4
Pan/tilt/zoom	E-flip, Auto-flip, 100 preset positions Pan: 360° (with auto-flip), 1.8°–100°/s Tilt: 180°, 1.8°–100°/s 12x optical zoom, 10x digital zoom, total 120x zoom Limited guard tour, Control queue
Video Resolution	1280x720 to 320x180
Compression	H.264 (MPEG-4 Part 10/AVC) - Baseline, Main and High Profiles Motion JPEG
Connectors	RJ45 10BASE-T/100BASE-TX PoE Multi-connector (cable not included) for AC/DC power, 4 configurable alarm inputs/outputs, mic in, line mono input, line mono output to active speaker.
Storage	Support for SD/SDHC/SDXC card (not included) Support for recording to dedicated network-attached storage (NAS)

Table 1 – AXIS P5514 features

The camera is powered from the 12VDC DC/DC but can directly powered with an Axis High Power over Ethernet (High PoE) midspan, allowing Axis network video products to receive data and power over the same Ethernet cable.

2.5 Hokuyo Laser Range Finder (optional)

The robot can be equipped with several models with our specific adaptors. Below you can see the laser range finders usually mounted.

URG-04LX-UG01 • Light weight: 160g • Wide Angle: 240º • Range: 5600mm. • Accuracy (±30mm).* • Distance and angle data output with high angular resolution (0.352°). • Low-power consumption :2.5W	
UTM-30LX • Outdoor Environment • Light weight: 370g • Wide Angle: 270° • Long Detection range: 30m • Compact: W60xD60xH87mm	
UST-10LX • Supply voltage 10～30V • Measurement distance 10m/20m • Field of view 270° • Interface Ethernet	

Table 2 – Laser Range Finders

3. Internal Elements

The following figure shows other non-mechanical components to be in consideration for maintenance tasks.

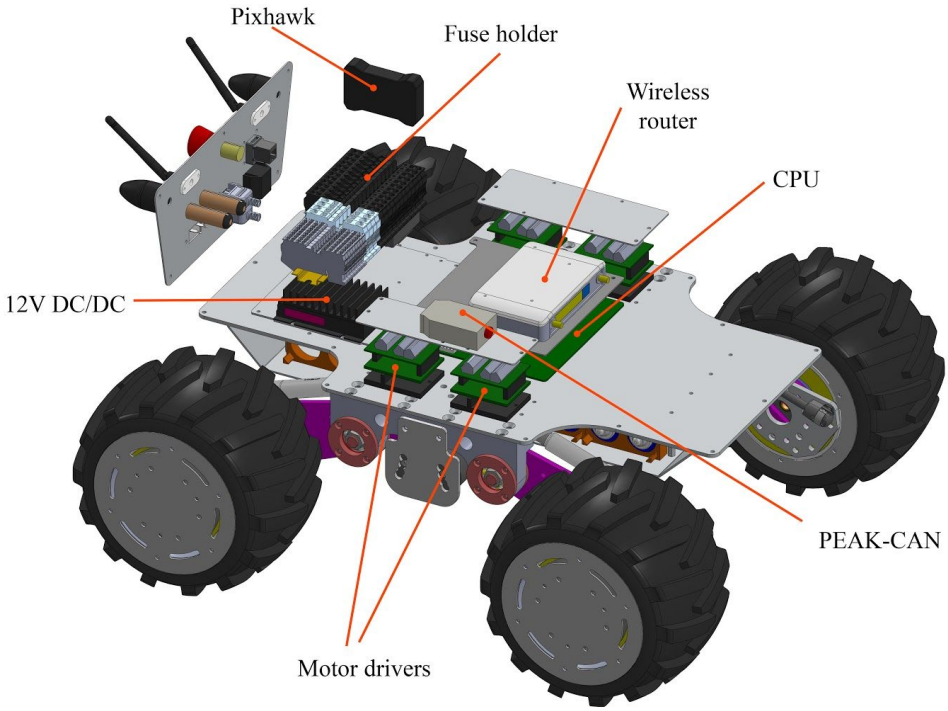


Figure 7 – Summit XL inside view

3.1 Embedded PC

The main board is a Mitac PD10BI MT with Intel Bay Trail J1900 Quad core processor and mini-ITX form factor. It can be easily replaced by other boards if needed. The computer is completed with 4GB of RAM and a 2.5” mSATA HDD mounted on the board.

Figure 8 – PC board

Form Factor	Low-profile Mini-ITX (20 millimeters [0.79 inches] x 170.18 millimeters [6.7 inches] x 170.18 millimeters [6.7 inches])	
Processor Chipset	Intel Bay Trail J1900 Processor with integrated graphics (*Remark: Compatible with J1800 and J2900)	
Memory	• Support for dual channel DDR3L 1333/1600(runs at 1333 MHz) SO-DIMMs	
	• Support for up to 8 GB of system memory on a single SO-DIMM (or 4 GB each by 2 SO-DIMM)	
	• 204-pin DDR3L SO-DIMM	2
Graphics	• Integrated graphics:	
	• Digital displays (HD-Out)	
	• Analog displays (VGA)	
	• Internal flat panel displays:	
	• LVDS	
	• Embedded DisplayPort* eDP*	
	• External graphics support via a PCI Express 1.0a x1 graphics add-in card connector	

Audio	• 2 + 2 Channel High Definition Audio (HD Audio) using a Realtek* ALC888S audio codec supporting:	
	• Analog stereo line-out (back panel jack)	
	• In-chassis stereo speakers support (3 W/3 Ω via an internal header)	
	• S/PDIF digital audio output (internal header)	
	• DMIC digital microphone input (internal header)	
	• Analog line-in (back panel jack)	
	• Front panel HD Audio/AC'97 headphones/mic support (internal header)	
	• 8-channel (7.1) HD Audio via the HD-Out interface	
Expansion Capability	• PCI Express 1.0a x1 add-in card connector Option: PCI Express 1.0a x4 add-in card connector by 2 lanes	1
	• PCI Express Full-/Half-Mini Card slot	1
	• PCI Express Half-Mini Card slot	1
Peripheral Interfaces	• USB 2.0 front panel ports	5
	• USB 3.0 back panel connectors (blue)	2
	• USB 2.0 high-current/fast-charging ports (Yellow)	2
	• SATA 3.0 Gb/s	2
	• SATA 3.0 Gb/s port (multiplexed with an mSATA port, routed to the PCI Express Full-/Half-Mini Card slot)	1
Legacy I/O	• Legacy I/O Controller (NCT6683D) that provides:	
	• Hardware management support	
	• Serial ports onboard headers	2
	• Parallel port via an onboard header	1
LAN Support	Realtek RTL8111G-CG Gigabit (10/100/1000 Mb/s) Ethernet LAN controller including an RJ-45 back panel connector with integrated status LEDs	
BIOS	• BIOS resident in a Serial Peripheral Interface (SPI) Flash device	
	• Support for Advanced Configuration and Power Interface (ACPI), and System Management BIOS (SMBIOS)	
Hardware Management	Nuvoton NCT6683D based subsystem, including:	
	• Voltage sense to detect out of range power supply voltages	
	• Thermal sense to detect out of range thermal values	

	• 3-pin system fan header with speed control
Power Requirement	• DC connectivity via back-panel DC jack(2.5mm/ ID, 5.5mm/ OD)
	• Internal 2 pin power connector
Environment	• Operating Temperature: 0°C to +60°C
	• Storage Temperature: -20°C to +70°C
Safety	• CE
	• FCC
	• UL

Table 3 – MITAC PD10BI features

The embedded Linux PC is located in the middle of the robot, under the Edimax wireless router. Its maintenance is equivalent to a standard PC station.

The main problem can be due to the accumulation of dust in the internal components, so it acts as thermal insulator. The heat generated by the components cannot be well dissipated because it is trapped in the dust layer.

The oil and grease particles contained in the environmental air mix with the dust, creating thus a big insulation layer that reflexes the heat to other components. This effect causes a reduction of the system useful life. On the other hand, the dust contain conductive particles that can generate short-circuits throughout the circuit boards or the peripheral cards.

The best way to extend the life of the equipment and make it free of reparations for many years is to clean it and remove the dust frequently.

3.2 Wireless Router

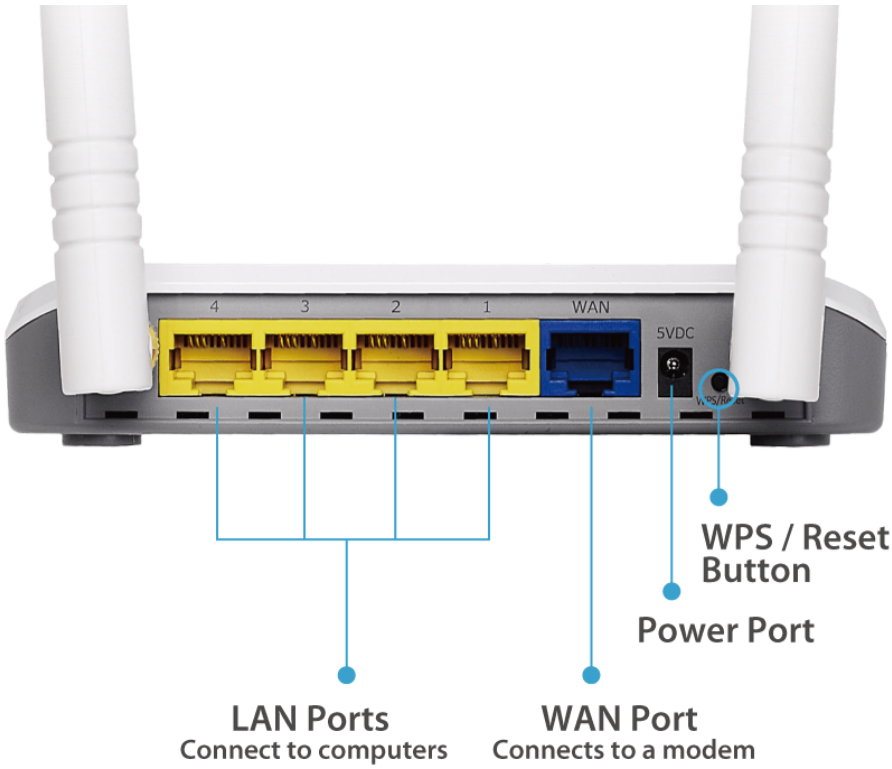


Figure 9 – EDIMAX BR-6428nC

The huge 9dB antennas are replaced with smaller 5dB antennas.

Technical Specification

- Wireless Data Transfer Rate: 802.11n: 300Mbps
- Supports router, access point & range extender modes
- Port triggering for special applications
- DDNS and SIP•Guest network
- Virtual server and DMZ hosting
- MAC/IP filter and URL blocking
- Static routing
- UPnP architecture
- VPN pass-through (IPSec/PPTP)
- Wi-Fi schedule control

3.3 DC/DC 12VDC & 5VDC

There is a 150W 12V DC/DC to provide a stable power supply for the electronic elements (PC, Axis camera, external power,…).

Figure 10 - 12V DC/DC

There is a small 5V DC/DC which powers the AGVCTRL-V2 (optional) and the motor drivers. It is located under the DIN rail.

Figure 11 - 5V DC/DC

3.4 Terminals & Fuses

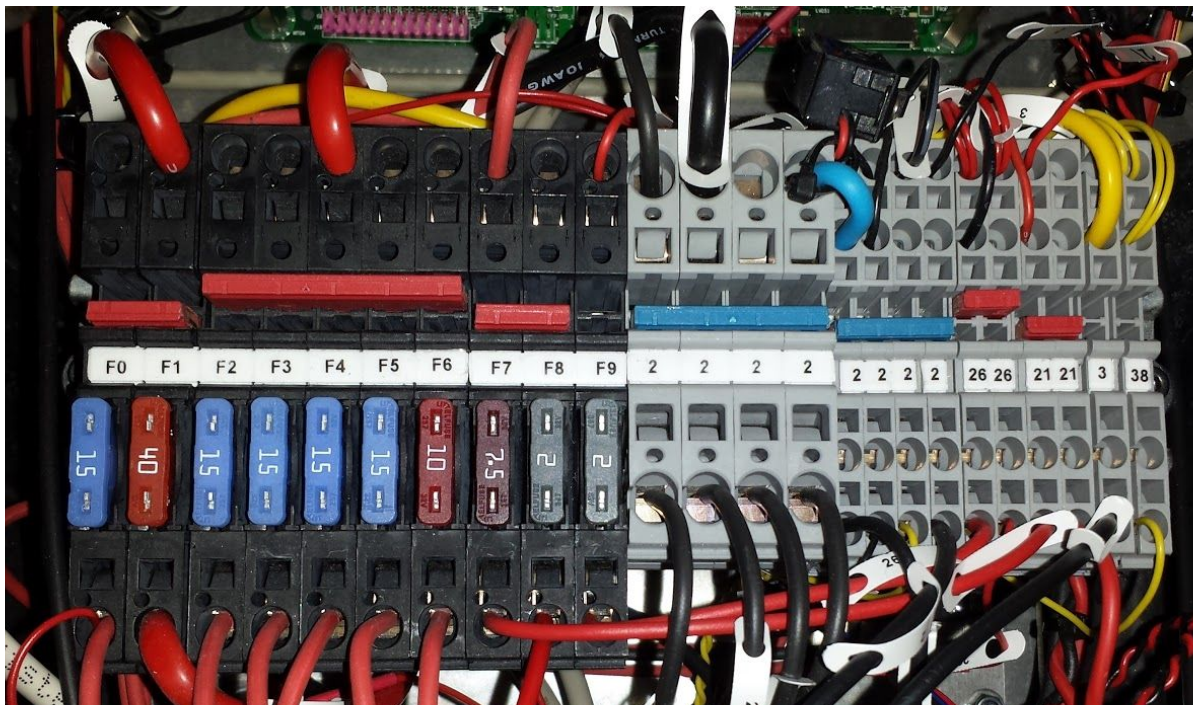


Figure 12- Fuses

At the picture you can see the DIN rail the following fuses:

- Fuse F0: 15A (blue) Back panel charge connector & switch S1.
- Fuse F1: 40A (orange) Main fuse, connected to battery directly.
- Fuse F2: 15A (blue) driver 1.
- Fuse F3: 15A (blue) driver 2.
- Fuse F4: 15A (blue) driver 3.
- Fuse F5: 15A (blue) driver 4.
- Fuse F6: 10A (red) 12V DC/DC converter INPUT.
- Fuse F7: 7.5A (brown) 12V DC/DC converter OUTPUT (+12V).
- Fuse F8: 2A (grey) Back panel 12V output (from DC/DC converter).
- Fuse F9: 2A (grey) 5V DC/DC converter OUTPUT (+5V).

3.4.1 Initial setup of the fuses

After unpacking the robot, you have to insert fuses from battery and back panel in the fuse holder before turning on the robot.

Important: Electrical damage danger. Check the power ON/OFF is in OFF position before plug any fuse in the fuse holder.

Figure 13. Power button in OFF position

- Insert 15A fuse in the fuse holder labelled with F0.
- Insert 40A fuse in the fuse holder labelled with F1.

See electric drawings manual for detailed information.

3.5 FPU Pixhawk (optional)

The Pixhawk FPU is used as an IMU (Inertial Measurement Unit) to better estimate the robot position, using the Pixhawk integrated gyroscope and accelerometers.

Figure 15 - Pixhawk FCU

Key Features:

- 168 MHz / 252 MIPS Cortex-M4F
- 14 PWM / Servo outputs (8 with failsafe and manual override, 6 auxiliary, high-power compatible)
- Abundant connectivity options for additional peripherals (UART, I2C, CAN)
- Integrated backup system for in-flight recovery and manual override with dedicated processor and stand-alone power supply (fixed-wing use)
- Backup system integrates mixing, providing consistent autopilot and manual override mixing modes (fixed wing use)
- Redundant power supply inputs and automatic failover
- External safety switch
- Multicolor LED main visual indicator
- High-power, multi-tone piezo audio indicator
- microSD card for high-rate logging over extended periods of time

Pixhawk is connected to the PC using a FTDI_USB-to-UART cable on the TELEM2 port. The following table shows the mapping between Pixhawk TELEM2 pins and FTDI pins or wire colors.

TELEM2		FTDI	
1	+5V (red)		Not Used
2	Tx (out)	5	FTDI RX (yellow) (in)
3	Rx (in)	4	FTDI TX (orange) (out)
4	CTS (in)	6	FTDI RTS (green) (out)
5	RTS (out)	2	FTDI CTS (brown) (in)
6	GND	1	FTDI GND (black)

Table 4 - FTDI_USB-to-UART pinout

More info in https://pixhawk.org/modules/pixhawk

4. Manual Controls

The gamepad functions are fully explained in the System Start-up Manual.

4.1 DualShock controller

The Gamepad used for the manual movements of the robot SUMMIT-XL is a Bluetooth Joystick. The receiver is located inside the robot and connected to one USB port of the computer.

The two joysticks are used for direction, traction and elevation and there are important controls like the speed level buttons that select between five speed ranges: very slow, slow, medium, high, and very high.

Figure 16 – Sony DualShock controller

5. Battery and Charger

The robot receives the power supply from a LiFePO4 battery pack. It is composed of eight 3.2V LiFePO4 cells and a protection circuit module. With this set of batteries the robot is able to operate up to 5 hours (up to 20 hours in lab environment), depending on the robot movements.

The robot circuit is powered when the general switch S1 is ON. The control DC/DC converter, that makes power to the different devices of control, is powered at the same time, and also the external 12V power connector.

The batteries are connected to the robot through the fuses. For charging the batteries there is a connector at the back panel of the robot where the charger can be connected. It is a direct connection, so the general ON/OFF switch doesn't affect the charging. It is possible to charge the robot and keep working at the same time without any problem.

Full charging time is around 45-60 minutes for the supplied charger. Do not use other chargers without checking battery specifications.

To charge the robot, you must follow this instructions strictly:

Step 1. Connect the charger to the back panel of the robot (**without being connected to the general power supply**).
Step 2. Connect the charger to the general power supply.
Step 3. Turn on the charger and complete one charging cycle.

IMPORTANT: When the charging process is finished, disconnect the charger from the robot and from the general power supply. Do not let the robot unattended during charging process.

5.1 LiFePO4 battery pack

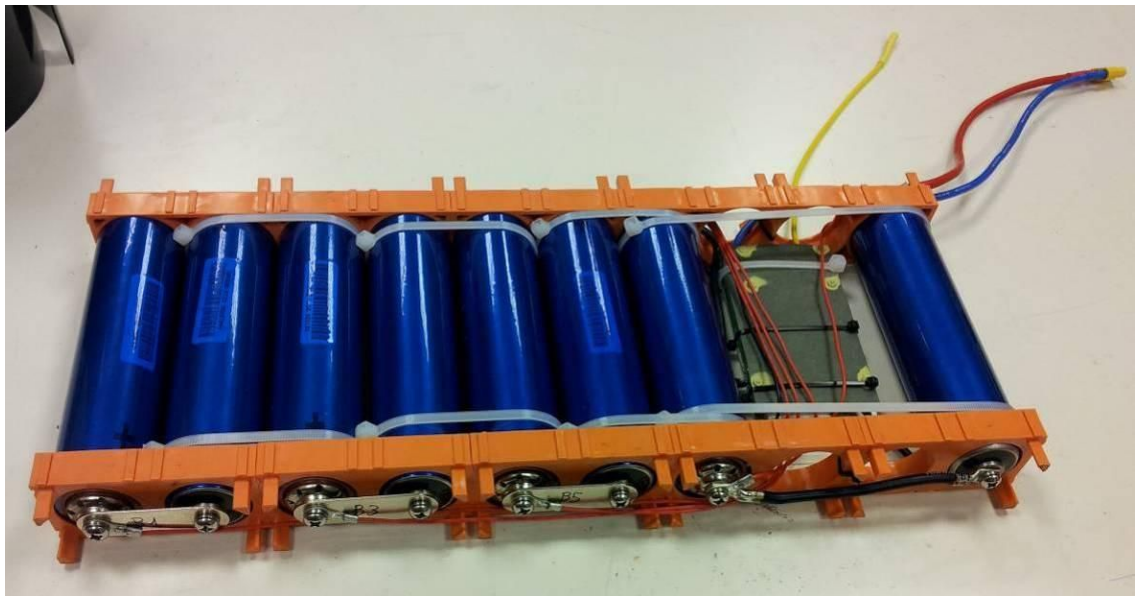


Figure 17– LiFePo4 Battery Pack

The battery pack is composed of eight LiFePO4 cells and a protection circuit module. The whole package is protected with shrinkable tube.

The batteries must be kept clean and dry in order to avoid escape currents. Check the wear out of the battery wires to prevent short circuits.

The battery can be separated from the robot by taking out the bottom aluminum protection and unplugging the power supply connector (red and blue wires) and the charge connector (yellow wire).

It is recommended to have the robot upside-down to do this process. The battery weight is 4kg and will fall when the screws are removed.

Recharge the batteries ASAP if fully discharged. Keeping the voltage low for a long time will greatly reduce the lifecycles.

5.1.1 LiFePO4 Cell

Figure 18 LiFePo4 cell

Specifications:

- Normal capacity 15000mAh
- Normal voltage 3.2V
- Inter impedance <8mOhms
- Maximum continuous Discharge Current 10C(150A)
- Charging Temperature: -10 – 45ºC (14 – 113º F)
- Discharging Temperature: - 20 – 60ºC (14 – 140ºF)
- Cycle Performance: >2000 (80% of initial capacity at 1C rate)
- Standard Charging current: 1C (15A), Max. 5C (75A)
- Weight: 500g

5.1.2 Protection circuit module

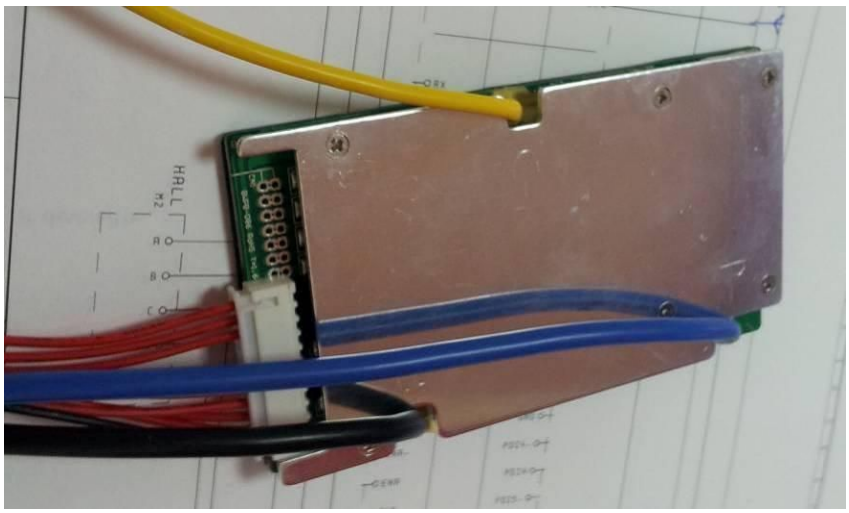


Figure 19– Protection circuit module

24V BMS 8CELLS 30A	
Item	8 series balancing guard shield
Over charge protection (V)	3.95±0.025
Over charge recovery (V)	3.80±0.05
Over discharge voltage (V)	2.2±0.1
Over discharge recovery (V)	Cut load or charge
Normal working current (A)	30
Over current protection (A)	60
Internal resistance (m/ohm)	<30
Charging balancing current (mA)	60
Charging balancing voltage (V)	3.63±0.03
Over charge postpone time (mS)	1.2
Over discharge postpone time (mS)	144
Temperature protection (℃)	65℃ (option)
Temperature characteristic	±1.0mv/℃
Working temperature (℃)	-10~+60
Storage temperature (℃)	-30~+85
Power loss (uA)	<400 (Vn=3.2v normal) <200 (Vn=2.2v Under-voltage)

Table 5 – Battery pack characteristics

5.2 LiFePO4 Smart Charger

Figure 20– LiFePo4 Smart Charger

The Smart Charger is designed for rapidly charge 29.2V (8 cells) LiFePO4 Battery pack. IMPORTANT: CHECK POWER SELECTION BEFORE PLUGGING IT

Specifications:

- INPUT
  - 115/230VAC Worldwide power input support by **Adjustable switch**
  - Input frequency 50-60Hz
- CHARGE
  - Charging current: 12A
  - Protection
    - Short circuit protection
    - Over voltage protection
    - Over current protection
    - Reverse polarity protection
  - The charger will cut off automatically if battery is fully charged
- OUTPUTS
  - 29.2VDC (8S x 3.65V)

- LEDs Status
  - o LED1 RED: AC Power on
  - o LED2 RED: Charging
  - o LED2 GREEN: Charging completed or battery not connected
- Temperature
  - o Operating temperature: -5ºC ~ +40ºC
  - o Storage temperature: -10ºC ~ +70ºC

Caution:

- The charger is designed for indoor use only.
- The charger should be placed horizontally and operate in well ventilated condition, avoid humidity and keep it away from inflammable explosive material.
- The aluminum case is a heat sink, do not cover it.
- Do not disassemble the charger due to high voltage inside.

Figure 21– LiFePo4 Smart Charger Front view

Figure 22– LiFePo4 Smart Charger Rear view

If you have trouble charging batteries check these:

Charger LED1 is off	Check charger Power Switch
	Check charger Input Fuse
Charger LED2 is green	If battery is close to 29.2V is already charged
	Check if charger connector is properly attached at the robot back panel
	Check charger Output Fuse
	Check Summit XL Fuse F0

Table 6 – Charging trouble tips

6. Communication Diagram

The following figure shows the communication diagram existing inside the robot.

The functionality of the system can be further extended by using the free Ethernet ports and free USB port (inside and outside).

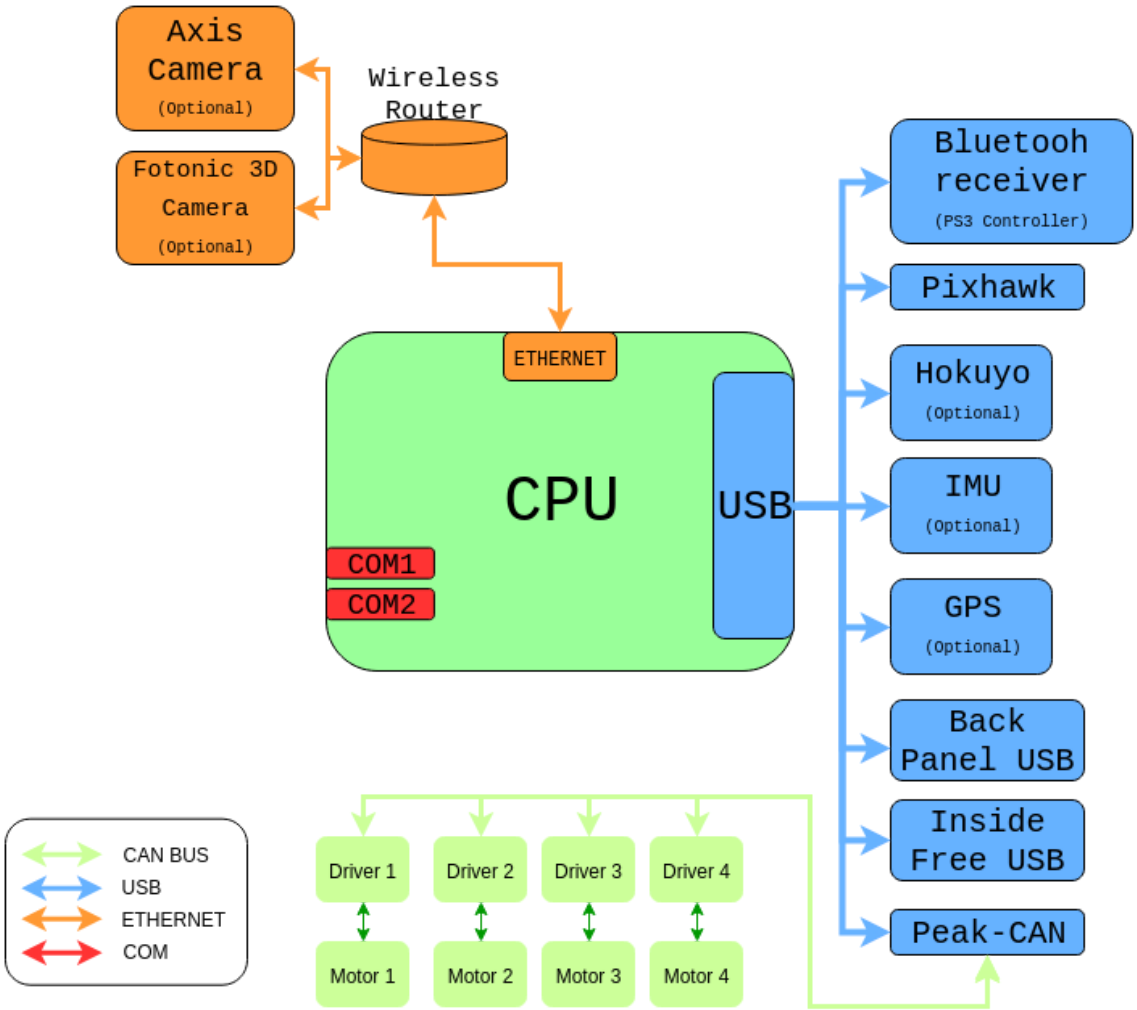


Figure 23– Communications diagram

7. Maintenance Summary

In the previous parts some main parts of the vehicle and components that need maintenance or only supervision have been mentioned. The following table summarizes all the elements that need maintenance and the periodicity of this maintenance.

	Often	*Every 6 month*	*Observations*
Screws	Check they are not loosen.		
Tires		Visual control of the wear rate.	Replace when needed
Outer wires		Visual control of the wear rate.	If wear appears, protect them with Shrink tube, Vulcan tape or similar.
Bearings		Control state.	If any damage appears, it is recommended its replacement by a new one.
Battery	Control Batteries Voltage, don't let the batteries get fully discharged	Check battery autonomy	Recharge ASAP if fully discharged
PC		Interior Cleaning. Visual control of the correct work of the fan (if installed).	

Table 7 – Maintenance summary

8. Basic Drawings

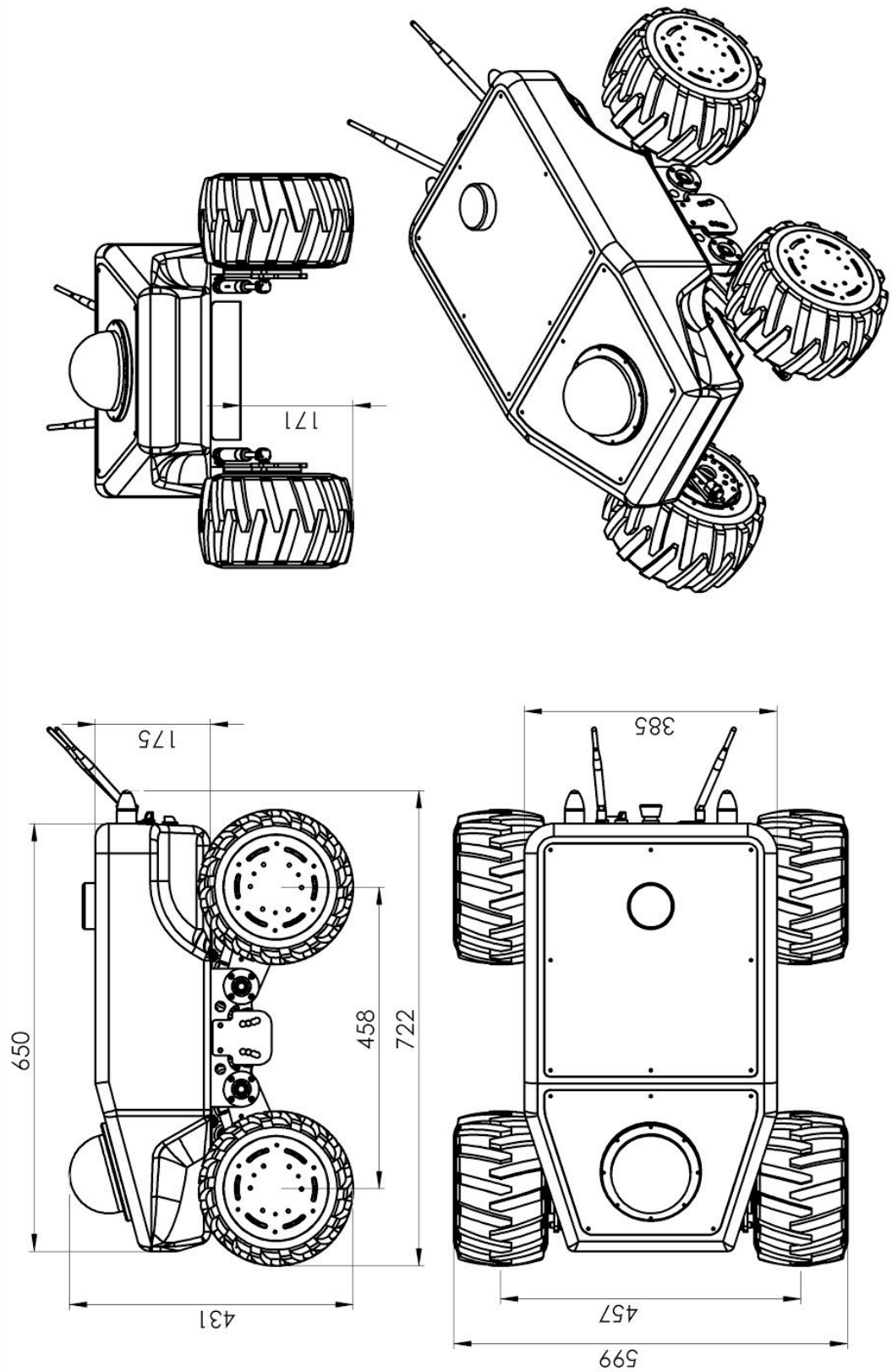


Figure 24– External robot drawings