

# NIFTi platform User's Manual

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## Basic usage, handling & maintenance

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## History

Revision	Date	Author	Description of changes
0.1	03.05.11	Patrick Balmer	Initial version
0.2	25.05.11	Patrick Balmer	Integrating comments from PL and LM
0.3	26.05.11	Nicola Tomatis	Small updates
1.0	26.05.11	Patrick Balmer	Release for consortium
1.1	30.05.11	Patrick Balmer	Adding chapter 5.1, definition of referential
1.2	16.06.11	Patrick Balmer	Adding chapter 3.1 and 3.2 and minor changes
2.0	16.06.11	Patrick Balmer	Release for consortium with platform delivery

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## Preliminary remarks

This user manual:

- Must be read carefully and understood.
- Must be considered as part of the system.
- Must be conserved during the entire life of the system.
- Must be transmitted to all users of the system.

## Overview

### Presentation of the platform

#### 1.1 Introduction

The NIFTi EU project aims to study the cooperation between a human and a robot working together in a dynamic environment with a novel robot platform for urban search & rescue.

The platform presented in this user manual has been designed following the specification elaborated together with the partners of the project. The complete specification can be found in *Deliverable 6.1.1: Platform specification and design*. Information regarding the manufacturing of the platform can be found in *Deliverable 6.1.2 Platform manufacturing*.

#### 1.2 Delivered items

The delivery consists in:

1. The NIFTi platform.
2. 1x Battery.
3. 1x Battery charger.
4. 1x Dedicated packing case.
5. This user manual.

### 1.3 Platform description

The platform is based on a 2 simple bogies configuration mechanically connected to the body via brackets. Both bogies are connected together with a differential.

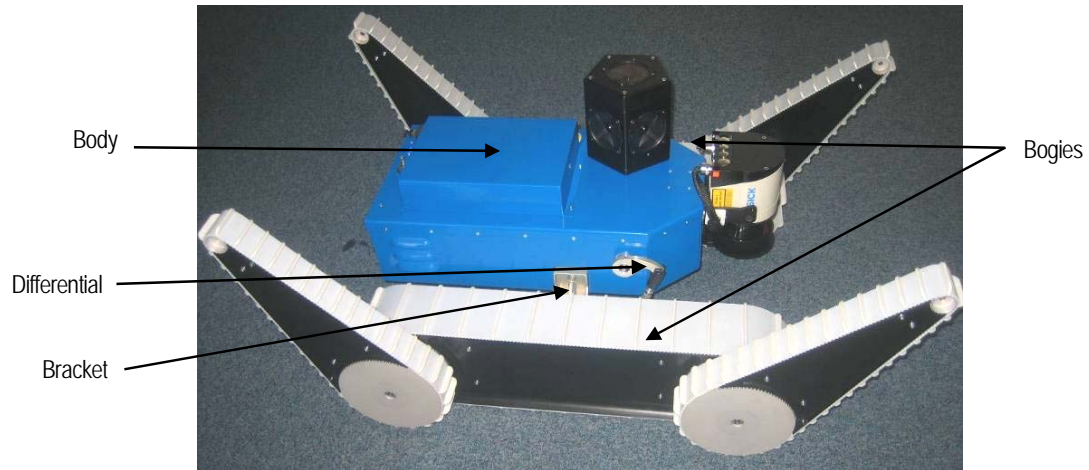


Figure 1. Platform general view

#### 1.3.1 Bogie

The bogie is composed of the main track and of two flippers. Each flipper can be controlled individually.

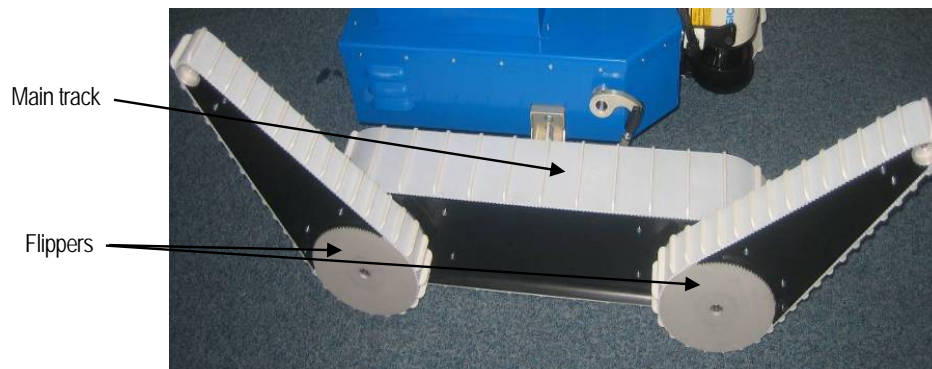


Figure 2. Bogie

The traction of the main track and of the two flippers tracks is done by a single motor, embedded in the front wheel. The flippers can be moved during platform movements. The bogie also contains the motors controllers (2 flippers and 1 traction).

## 1.3.2 Body

The body contains the main electronic board of the platform:

- Embedded PC, mini ITX mother board with a quad core processor.
- Power PCB, used for the power distribution and management within the platform.
- 3D PCB, used for the management of the 3D sensor rotation. Also routes the CAN bus to the bogies.

And the embedded sensors:

- 3D sensor (a rotating 2D laser scanner).
- Omnicam, standard off the shelf camera.
- IMU and GPS, off the shelf component. The IMU is placed inside the body, the GPS antenna is placed on the top of the body.

The main body also contains the following components:

- Emergency stop button.
- Pull wire emergency switch.
- Status LEDs.



Figure 3. Platform body

The following components are protected by the battery cover:

- A Li-ion battery is used to power the platform.
- Two Battery connectors, to enable battery hot swap (Refer to *4.1.4 Battery hot swap* for the procedure).
- A main switch, to turn ON/OFF the platform.
- An external power supply connector, to power the platform.

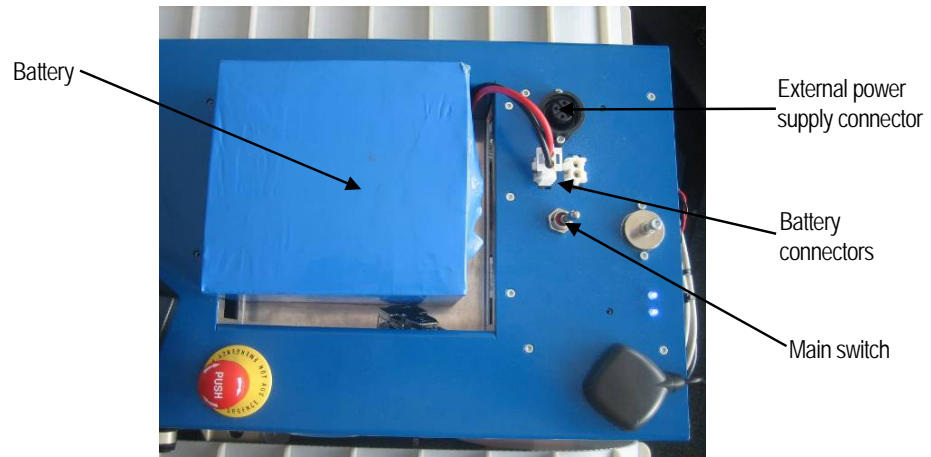


Figure 4. Components placed under the battery cover

Removing the back cover of the platform gives access to:

- The embedded PC.
- Additional power supply terminals (2x).

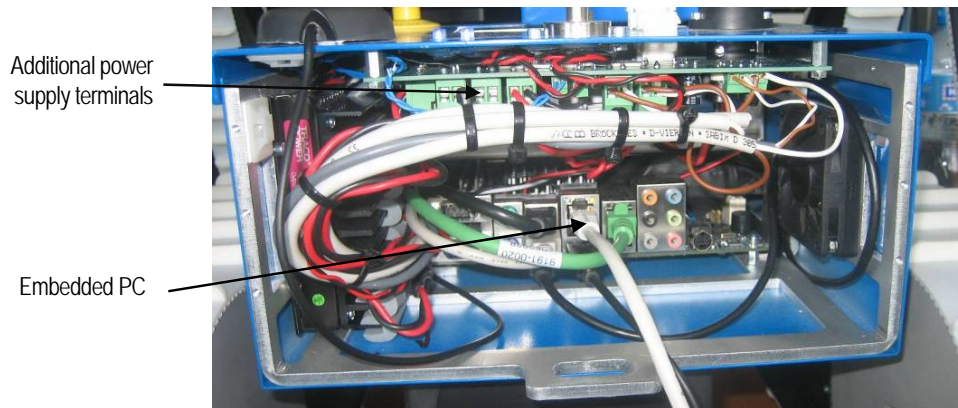


Figure 5. Access to the inside of the robot



### 1.3.2.1 Status LEDs

The platform comprises two status LED's:

- **Power ON**, indicates if the platform is powered.
- **Emergency status**, when OFF it indicates that the safety line is open. Refer to *2.4 Recover from an emergency* for more information.

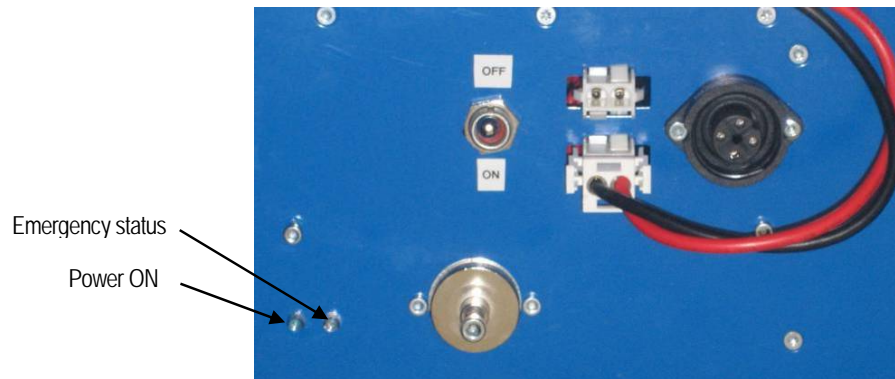


Figure 6. Status LEDs

### 1.3.3 Differential

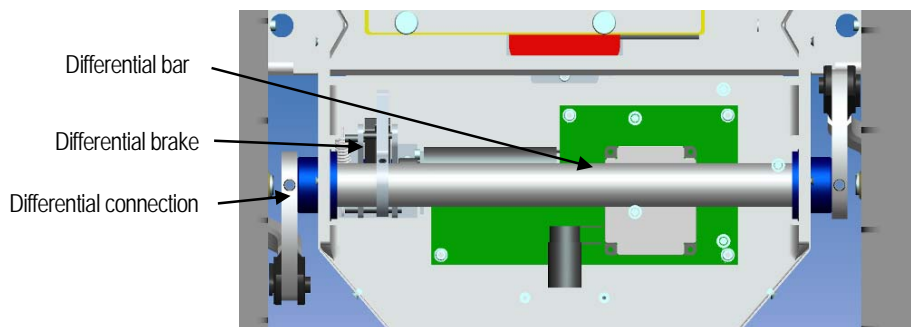


Figure 7. View of the differential

The differential connects the bogies together. The rotation of one bogie induces a rotation of the other bogie in the opposite direction. The purpose of the differential is to maximize the surface of tracks in contact with the ground.

The differential can be blocked in any orientation using its brake.

#### ***IMPORTANT***

Driving with a blocked differential in an inappropriate position may damage the robot!

### 1.3.4 3D sensor

The 3D sensor is placed at the front of the platform. The 3D sensor is a rotating 2D laser scanner. The rotation is  $+90^{\circ}/-90^{\circ}$  from the origin position as depicted below.

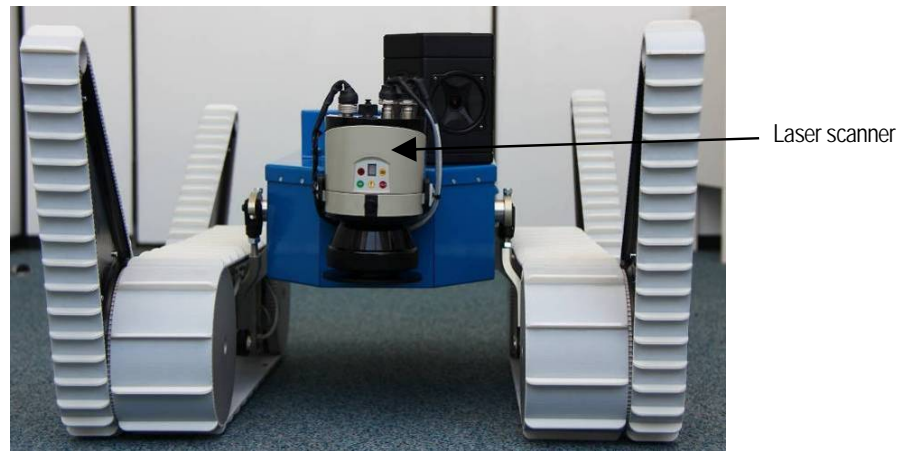


Figure 8. 3D sensor

#### ***IMPORTANT***

Don't move the 3D sensor by hand!

### 1.3.5 Omnicam

The omnicam allows getting a panoramic view all around the platform. It is placed on top of the platform.

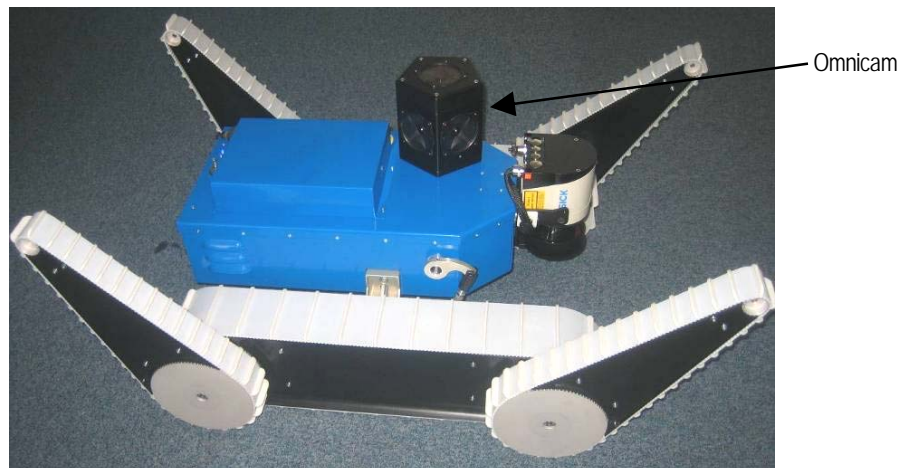


Figure 9. Omnicam

## 1.4 Main configurations

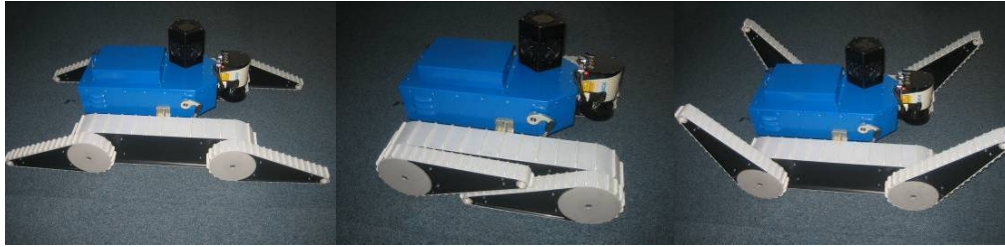


Figure 10. Three standard configurations, fully deployed (left) stowed (middle) and 45 ° (right)

The configuration of the platform can be modified by changing the orientation of the flippers. The main configurations are:

- Fully deployed: to maximize the surface on the ground and to drive over gaps.
- Stowed: for transport purposes.
- 45°: the flippers are not used. To drive on flat ground.

### ***IMPORTANT***

The main tracks must always touch the ground.  
Driving on the flippers only may damage the platform.

### ***IMPORTANT***

The stowed configuration is only used for transportation. Don't use the platform in stowed configuration (tracks interferences).

## 1.5 Components references

- Embedded PC: Kontron KTGM45/miTX Plus.
- Embedded CPU: Kontron CPU KTGM45-CPU\_Q9100 .
- 2D laser scanner: : SICK LMS-151 (P/N 1047607).
- Omnicam: Point Grey Ladybug 3 (P/N LD3-20S4C-33B).
- IMU/GPS: X-sens MTI-G (P/N MTI-G-28A53G35).
- USB-CAN: EMS-Wuensche (P/N CPC-USB/ARM7-GTI).

## 1.6 Non delivered items

### 1.6.1 External power supply

The platform can be powered by an external power supply, which is not provided. Refer to *4.1.5 External power supply* for the power supply data.

### 1.6.2 Tether

The platform has been designed in order to support tethering, meaning able to work wired to a fix point on the ground. No specific hardware is supplied.

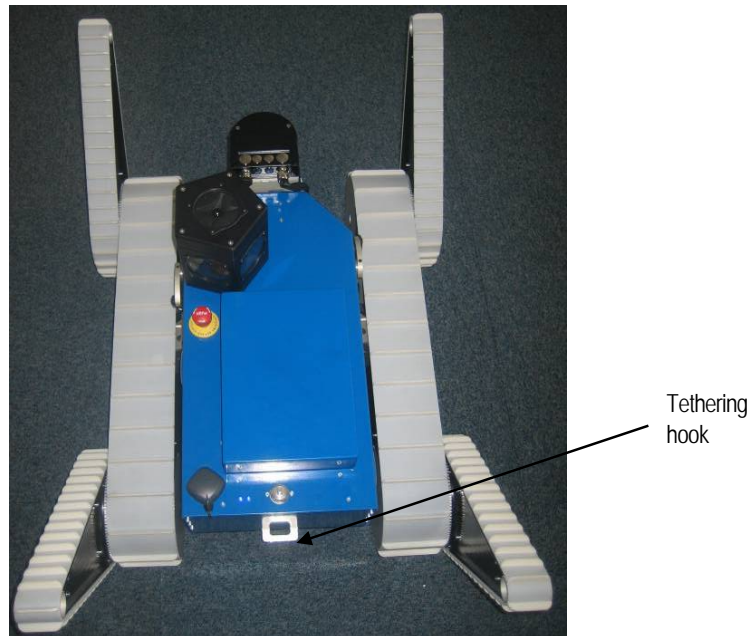


Figure 11. Tethering hook

For tethering, the user needs a rope or metallic wire for the mechanical fixation of the platform, to guarantee that the tether is strong enough. It will be fixed on the Tethering hook.

An additional rope can be fixed on the emergency pull device in order to activate the Emergency stop from a distance of the platform.

#### **IMPORTANT**

Tethering will be done at the sole responsibility of the user.

## Safety

### Safety system of the NIFTi platform

#### 2.1 Emergency stop button

As required for every machine, the NIFTi platform is equipped with an *Emergency stop button*. The Emergency stop button is placed on the top of the robot. When pressed, the safety line is open and the platform stops.

#### 2.2 Pull wire Emergency stop device

The NIFTi platform is also equipped with a *pull wire Emergency stop device*. This device is fixed to the body with a magnet. When removed from the platform, the safety line is open.

A rope can be attached to the pull wire Emergency stop device. By pulling on the rope, the user can trigger an emergency stop even at a distance of the platform.



Figure 12. Emergency stop button and pull wire Emergency stop device

## 2.3 Emergency

If you observe that the robot becomes dangerous for someone or something, you can either press the *Emergency stop button* or pull the *Emergency stop device*. The NIFTi platform will not be able to move until all devices are released.

### ***IMPORTANT***

The robot won't move if the Emergency stop button is pressed OR the pull wire pull Emergency stop device is removed.

The actuator of the 3D sensor is not affected during an emergency stop and will keep on moving.

## 2.4 Recover from an emergency

To recover from an emergency situation:

1. Insure the situation is safe again for surrounding people and hardware.
2. Bring all velocity set-points to 0 in order to avoid undesired platform motion after recovery of the Emergency stop.
3. Release the emergency stop button, turn it as indicated on the button and pull it upwards.
4. Put the pull wire emergency stop device back in place.
5. The platform is up and running.

### ***IMPORTANT***

Before recovering from an emergency, insure that the situation is safe again for people and hardware.

### ***IMPORTANT***

The 3D sensor actuator is not affected by an emergency stop. It will keep rotating.

## 2.5 Safety Warning and Disclaimer

### 2.5.1 Environment and conditions of use

The safety of the platform is only guaranteed if the environment complies with the specification, refer to *Deliverable 6.1.1: Platform specification and design* for the details.

***IMPORTANT***

The safety of the platform is **not** guaranteed if the environment does not comply with the specification.

***IMPORTANT***

The platform should not be used on soft sand, risk of the track going out of its way.

***IMPORTANT***

The delivered robot is a system for academic research.  
The robot should be used under the supervision of a competent person.

***IMPORTANT***

Disassembling components of the rover is forbidden without specific authorization of BlueBotics.  
The warranty is void if the platform is disassembled.

***IMPORTANT***

When authorized, disassembling is done under the sole responsibility of the user. BlueBotics is not responsible for a damage caused by the disassembling and/or reassembling of components.  
Warranty is void for the disassembled components.

## Commissioning and installation

### Platform preparation

#### 3.1 Platform unpacking

To unpack the platform:

1. Open transport box



Figure 13. Opened transport box

2. Untighten the bogie fixation strips.
3. Take the platform out of the box (hold it by the bogies, two people needed).



## 3.2 Platform packing

To pack the platform:

1. Prepare the platform; protect the omnicamera and the scanner. Put the flippers in stowed configuration.



Figure 14. Platform preparation

Pay attention to immobilize the scanner. It must be taped on the body in order to tolerate shocks and vibrations during transportation.

2. Prepare the transportation box. Put the strips in the bottom holders.



Figure 15. Transport box preparation

3. Put the platform in the box (hold it by the bogies, two people needed) and tighten the strips on the tracks.

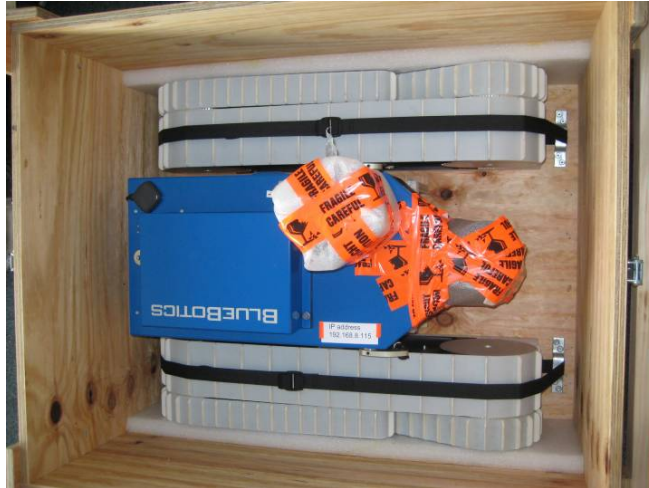


Figure 16. Put the platform in the box

**IMPORTANT**

The user is responsible to correctly pack the platform. Any damage during transport will be under his responsibility.

### 3.3 Platform stowing

In order to fit in a standard airline suitcase, the robot can be stowed. The procedure to stow the robot is as follow:

- 1) Put the flippers in "stowed" position.



Figure 17. Platform in stowed configuration

- 2) Remove the fixation screws.

- 3) Remove the differential fixation. From that point the platform does not hold by itself and two persons are needed to carry it.

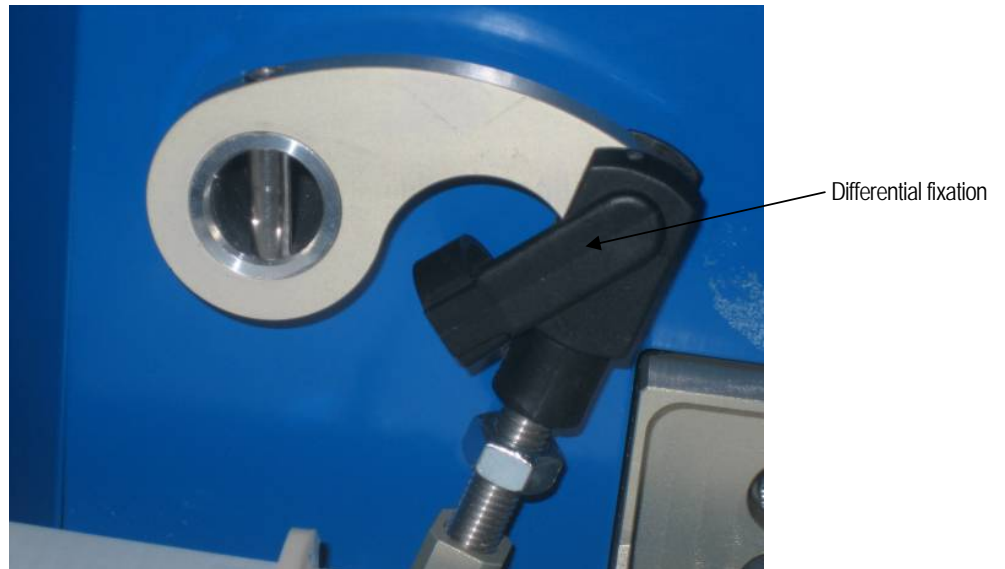


Figure 18. Differential fixation

- 4) Separate the body from the bogies and put it in between.



Figure 19. Stowed platform

Reassembling is done following the same procedure in the opposite order.

## Operation

### Working with the platform

#### 4.1 Power supply

The platform can be powered either by a battery (supplied) or by an external power supply.

***IMPORTANT***

Never connect the external power supply when a battery is connected on the platform.

Never connect a battery when the external power supply is connected to the platform.

##### 4.1.1 Batteries

The platform is supplied with one battery. The battery is equipped of 2 connectors.

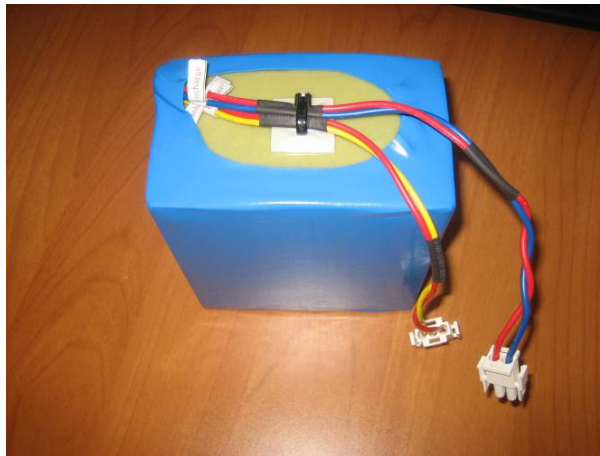


Figure 20. Battery

The two pins connector with the blue red wires is used to connect the battery to the platform



Figure 21. 2 pins connector used to connect the battery to the platform

The three pins connector with the yellow red wires is used to charge the battery.

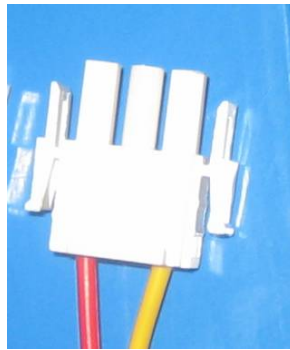


Figure 22. 3 pins connector used to charge the battery

#### 4.1.2 Batteries charging

The platform is delivered with a battery charger. To charge the battery:

- 1) Power the battery charger.
- 2) Plug the battery to the dedicated connector. The battery starts charging.
- 3) Wait until LED2 is green.

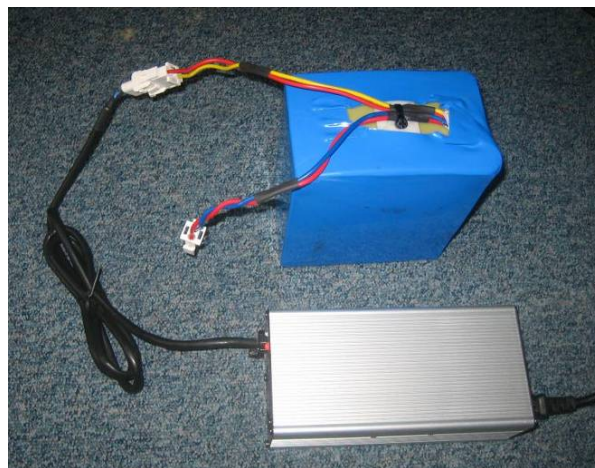


Figure 23. Charging the battery

The charger is equipped with two status LEDs. The LEDs description is found on the charger and is as follow:



Figure 24. Charger LEDs status

***IMPORTANT***

Don't let the battery unattended (e.g. at night) during charging to prevent any risks.

#### 4.1.3 Battery installation on the platform

The battery is installed on the platform as follows:

- 1) Place the battery in place in the body.
- 2) Connect the battery to one of the two battery connector.
- 3) Install and fix the battery cover.

***IMPORTANT***

Never use the platform without the battery cover.

Note: The battery cover installation deactivates the battery protection circuit, needed during the hot swap to avoid the full battery to discharge in the empty one.

#### 4.1.4 Battery hot swap

In order to avoid rebooting the platform after a battery replacement, a hot swap of the batteries is possible and should be done as follow:

- 1) Remove the battery cover.
- 2) Plug the charged battery.
- 3) Unplug the empty battery and remove it.
- 4) Place the charged battery in place.
- 5) Put the battery cover back in place.

**IMPORTANT**

Never make a hot swap between a battery and the external power supply.

#### 4.1.5 External power supply

The platform is equipped with a connector for external power supply. The characteristics of the external power supply are given here:

- Voltage: 48 V (+/-5%)
- Current: 10 A max
- Connector type (robot side): Binder serie 693,P/N 09 4224 00 04
- Connector type (power supply side): Binder serie 693, P/N 99 4221 00 04 (supplied)

Pinning:

Pin number	function
1	GND
2	+48V
3	Not_used
4	Not_used

The external power supply does not recharge the battery.

**IMPORTANT**

Never connect a battery on the platform when already connected to the external power supply.

**IMPORTANT**

Never make a hot swap between a battery and the external power supply.

**IMPORTANT**

As the external power supply is not delivered with the platform, insure your external power supply is compatible with the above specification.

## 4.2 Starting the platform

To switch ON the platform, put the main switch on the ON position.

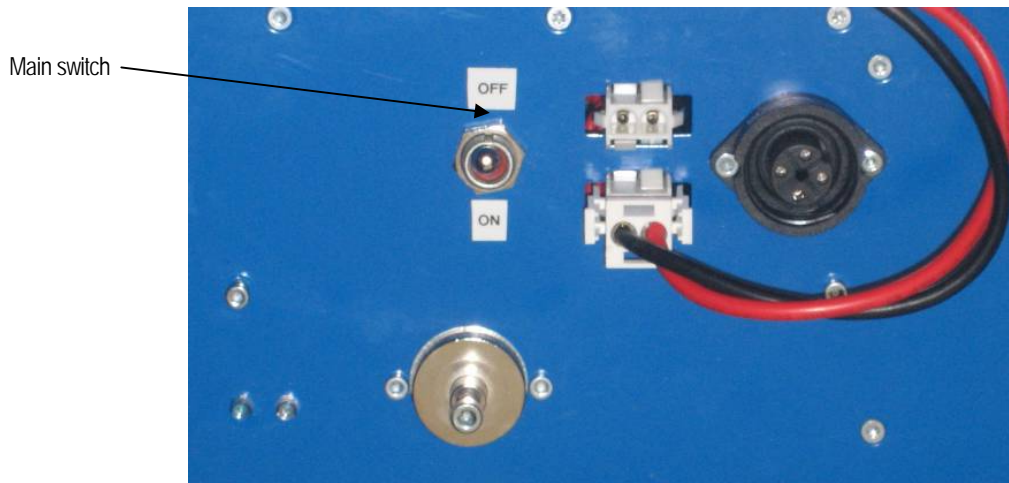


Figure 25. Platform main switch

## 4.3 Calibrating the platform

### 4.3.1 Chassis calibration

The platform is delivered fully calibrated. However, a calibration procedure must be performed after any hardware modification e.g. the replacement of a flipper or a motor controller. The procedure is as follows:

1. Turn on the platform.
2. Place the platform on a flat ground.
3. Start the calibration application<sup>1</sup>.
4. Push on the flippers to fully deploy the chassis (as depicted in *Figure 10. Three standard configurations, fully deployed (left) stowed (middle) and 45 ° (right)*).
5. Press "Enter" to complete the procedure. Note that the flippers will move towards each other. This is part of the calibration procedure.

## 4.4 Shutting down the platform

To turn OFF the platform:

- 1) Shutdown the embedded PC.
- 2) Flip the main switch on the OFF position.

<sup>1</sup> The calibration application is part of the software delivered with the platform (see section 5.2 API description)



## 4.5 Platform interface

### 4.5.1.1 Spare power supply

Two additional power supply terminals are available on the platform to power optional devices. The terminals are situated on the power PCB and accessible from the back of the platform. For safety reasons, fuses have been added, do not exceed these values:

- Voltage: 24 V.
- Power: max 50 W.

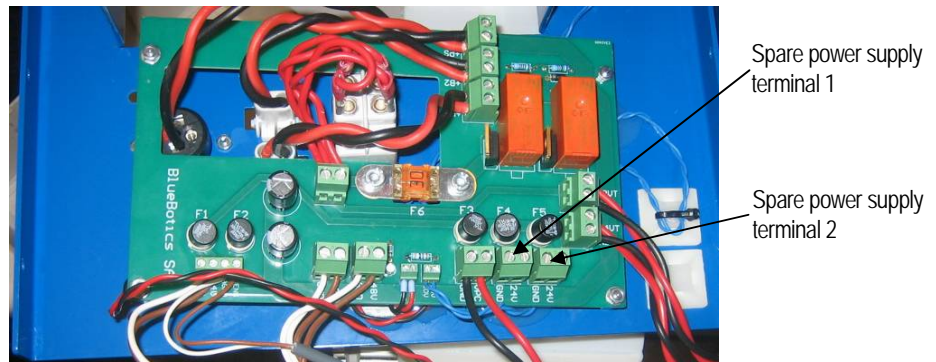


Figure 26. Power PCB with spare power supply

#### ***IMPORTANT***

Carefully check the polarity before connecting an external device.

#### ***IMPORTANT***

Remove any power supply (battery or external power supply) before connecting any device

#### 4.5.1.2 Embedded PC interface

The following connectors are available on the embedded PC:

- 2x USB.
- 2x Ethernet.
- 1x RS-232.
- VGA output.
- PS2 for mouse and keyboard.
- Audio stack.

For accessing these connectors refer to *1.3.2 Body*.

## Software

### Low level software description

#### 5.1 Definition of referential

The following sketches define the referential and give important dimensions.

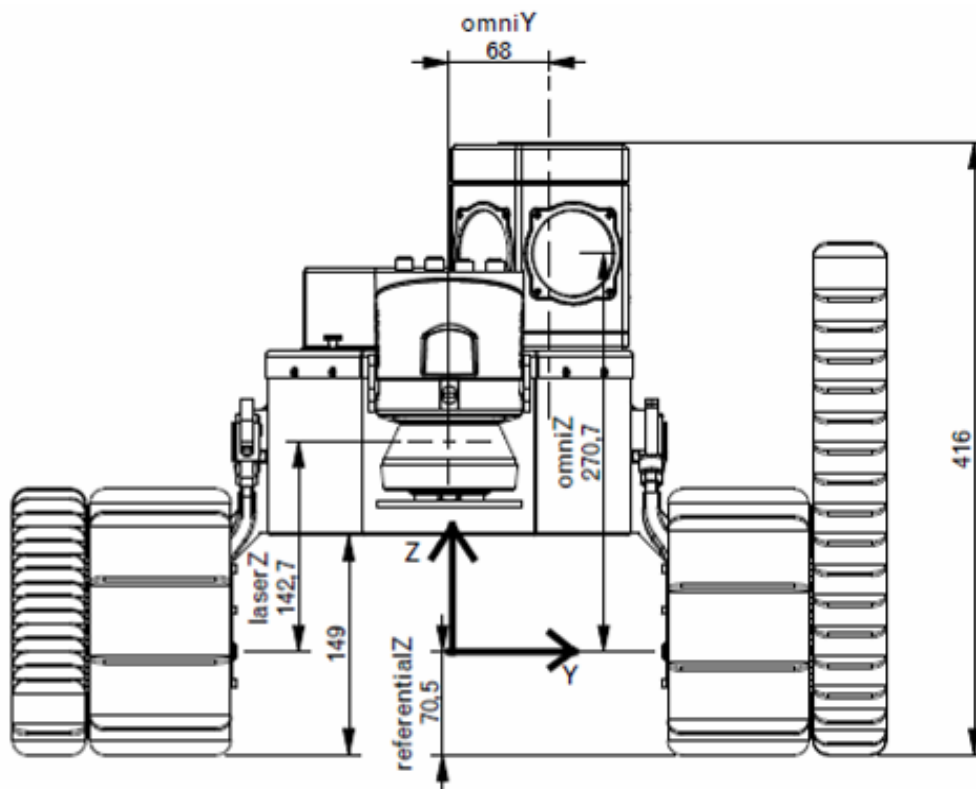


Figure 27. Front view of the platform

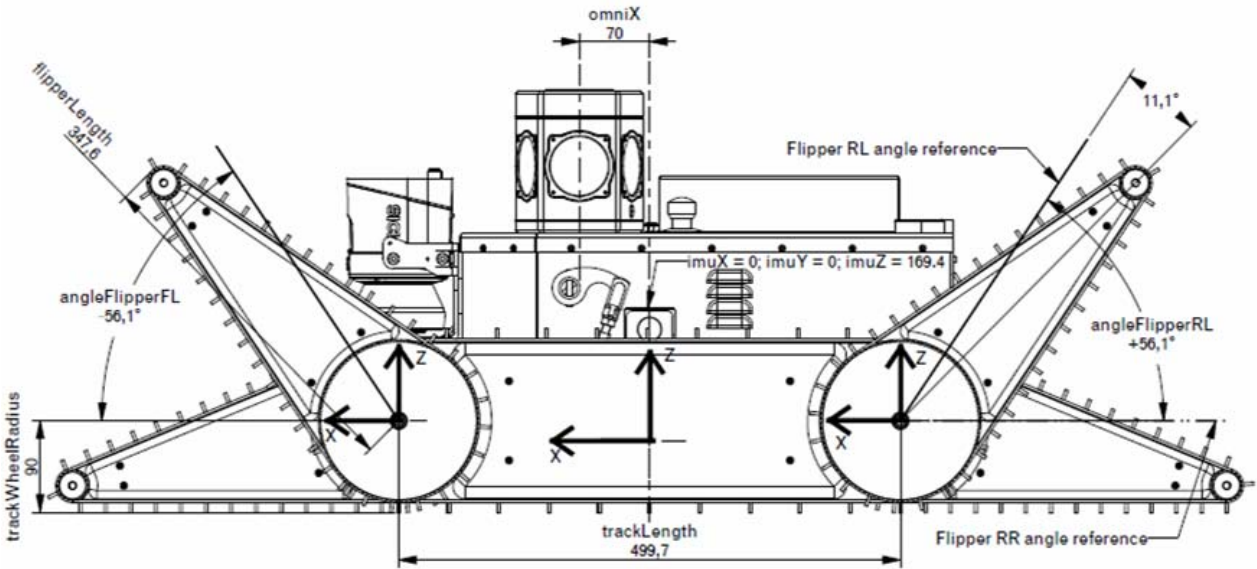


Figure 28. Side view of the platform

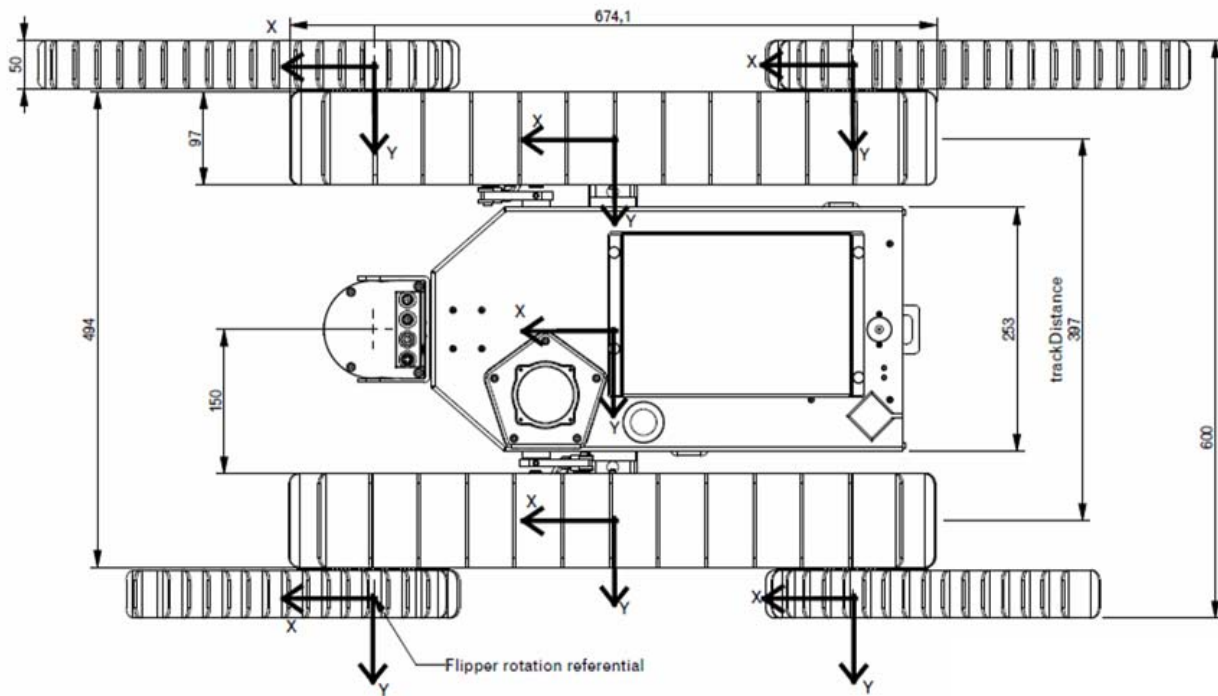


Figure 29. Top view of the platform

## 5.2 API description

The API description is available on the Project SVN.

## Maintenance

### Preventive maintenance steps

#### 6.1 Preventive maintenance

The mechanical components of the rover are maintenance free.

Electrical components are maintenance free. Batteries are also maintenance free but have a limited life time. For more information, refer to the batteries supplier.

#### 6.2 Fuses

The platform is equipped of 6 fuses, which are placed on the Power PCB, accessible by the back of the platform, refer to *Figure 5. Access to the inside of the robot.*

On the power PCB, the fuses are positioned as shown on the picture below. The function and value of the fuses are listed in the following table:

Name	function	Value	Type
F1	3D PCB power protection	5 A	Schurter MSF250...AF
F2	Vbat measure protection	100 mA	Schurter MSF250...AF
F3	PC alimentation protection	5 A	Schurter MSF250...AF
F4	Additional power supply 1	3.15 AF	Schurter MSF250...AF
F5	Additional power supply 2	3.15 AF	Schurter MSF250...AF
F6	Main power protection	30 A	Pudenz BF1

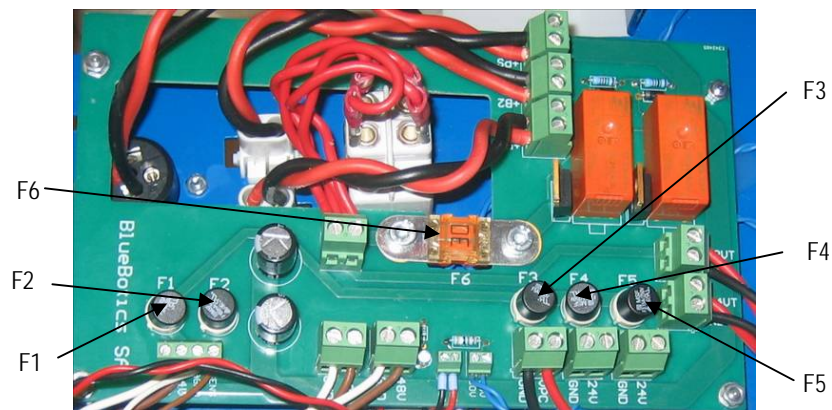


Figure 30. Power PCB

### 6.3 Cleaning the platform

Clean the platform with a soft wet cloth.

***IMPORTANT***

Never clean the platform either with a pressurized water jet or with solvent.