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Mobile Robots at your Service

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The Shrimp III Robot

User's Manual

Revision 2010-10-01

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Introduction

This document provides a description of the Shrimp platform intended for the user of the robot. It includes information about the daily usage tasks like charging, as well as a description of the various status signals of the robot.

The serial protocol used to control the robot is described in the separate document "Controlling the Shrimp III".

This document is a pre-release. As such, the information contained may not be exhaustive, and the user is encouraged to contact BlueBotics SA before attempting any operation not described in this document.

BlueBotics SA cannot be held responsible for any damage due to bad handling or manipulation errors.

Disassembling or modifying the robot mechanical parts or electronics voids the warranty.

Basic electronics

The Shrimp motion is done through six DC motors, one in each wheel, and two servos, one on the front wheel and one on the rear wheel. An electronic module, including the controller and power, controls each DC motor. An additional module drives the two steering servos.

A power module on which the main 12V battery is connected supplies the different voltages needed by the platform (logic: 5V, servo power: 5V, motor power: 12V).

A master module supervises all the peripherals to control the motion of the shrimp, steering angle and forward velocity, and the power supply. The master can be accessed either through a standard RS-232 serial port or through the infrared port with the provided RC5 IR remote control.

Motion controller, steering

A motion controller is implemented in the master module to control the rover. The master module requires the forward velocity and the steering angle to compute adapted commands for each wheel. The output of the controller is sent to the respective motor and servo controller slave modules.

A simple position controller drives the servos. Their angular range is max ±90°. A speed controller drives the six motors of the wheels.

For steering, the front and the rear wheels are oriented in the corresponding direction and the two bogies are working as a differential drive system. As a result, the Shrimp platform can turn with a very small radius.

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IR Remote control

The Shrimp can be driven by hand with a standard infrared remote control. Point the remote control to the receiver (shown in fig.2) from a maximum of 4 m.

The remote control must be placed in SAT mode.

- The red ***power*** turns the robot on and off.
- The numeric keys form a sort of joystick, and allow maneuvering the robot. The ***2*** and ***8*** buttons respectively increase and decrease the velocity by one step. The ***4*** and ***6*** buttons turn the wheels by one step left and right, respectively. The ***5*** buttons sets the front and rear wheels straight, keeping the velocity unchanged.
- The diagonal buttons ***1***, ***3***, *7* and ***9*** combine the functions of their two neighbors, so the ***1*** button for example increases the velocity and turns the wheels left by one step.
- The ***0*** button sets the velocity to zero and sets the front and rear wheels straight.

The remote control is delivered with the correct configuration for SAT mode. In case this configuration is lost, e.g. due to changing the battery, the remote control should be configured for SAT mode 225. To re-configure the remote control, follow this procedure:

- Press and hold the SET button, and press the SAT button. Release both buttons. The red light should stay on.
- Enter the code 424. The red light should flash after every digit, and it should switch off after the last digit.

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RS-232 connection

In most application, the Shrimp rover can be controlled by an on-board host computer – such as a PDA – through the RS-232 port of the master. The communication can be established with a SubD-9 male/female cable (point-to-point, not null modem) connected to the host computer.

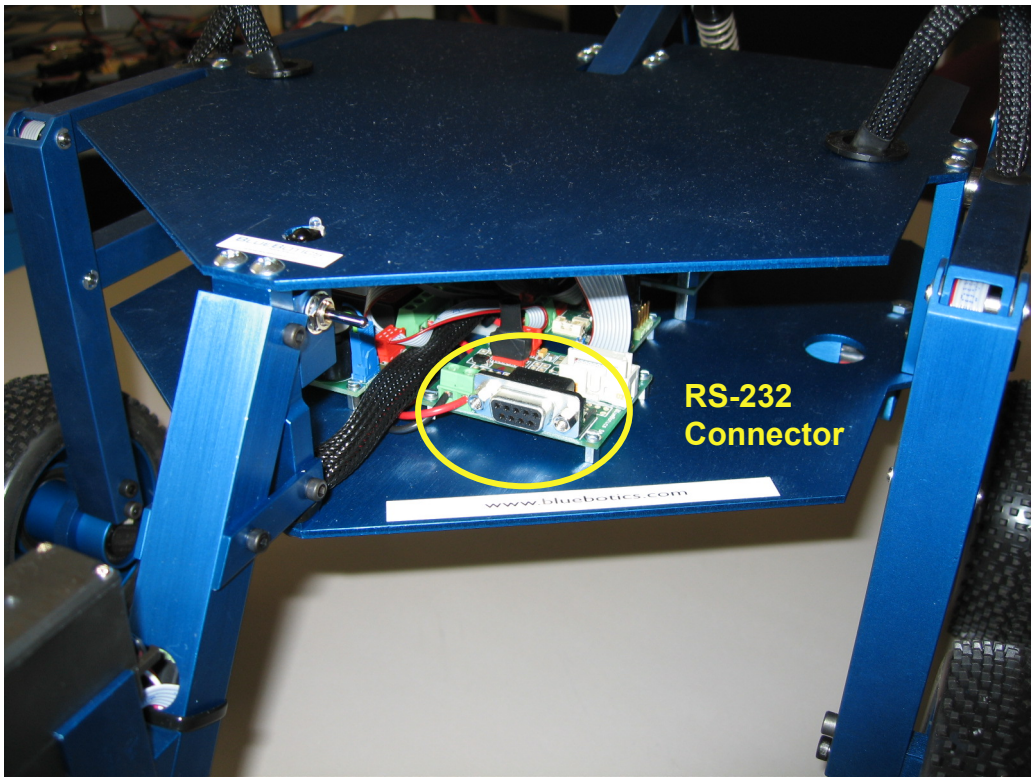

Fig. 1: Position of the RS-232 connector of the Shrimp

RS-232 parameters are: Baud rate 57600, Data bits 8, No parity, 1 Stop Bit, No Flow Control

The communication protocol over the RS-232 port is described in the document "Controlling the Shrimp III".

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Control and status item locations

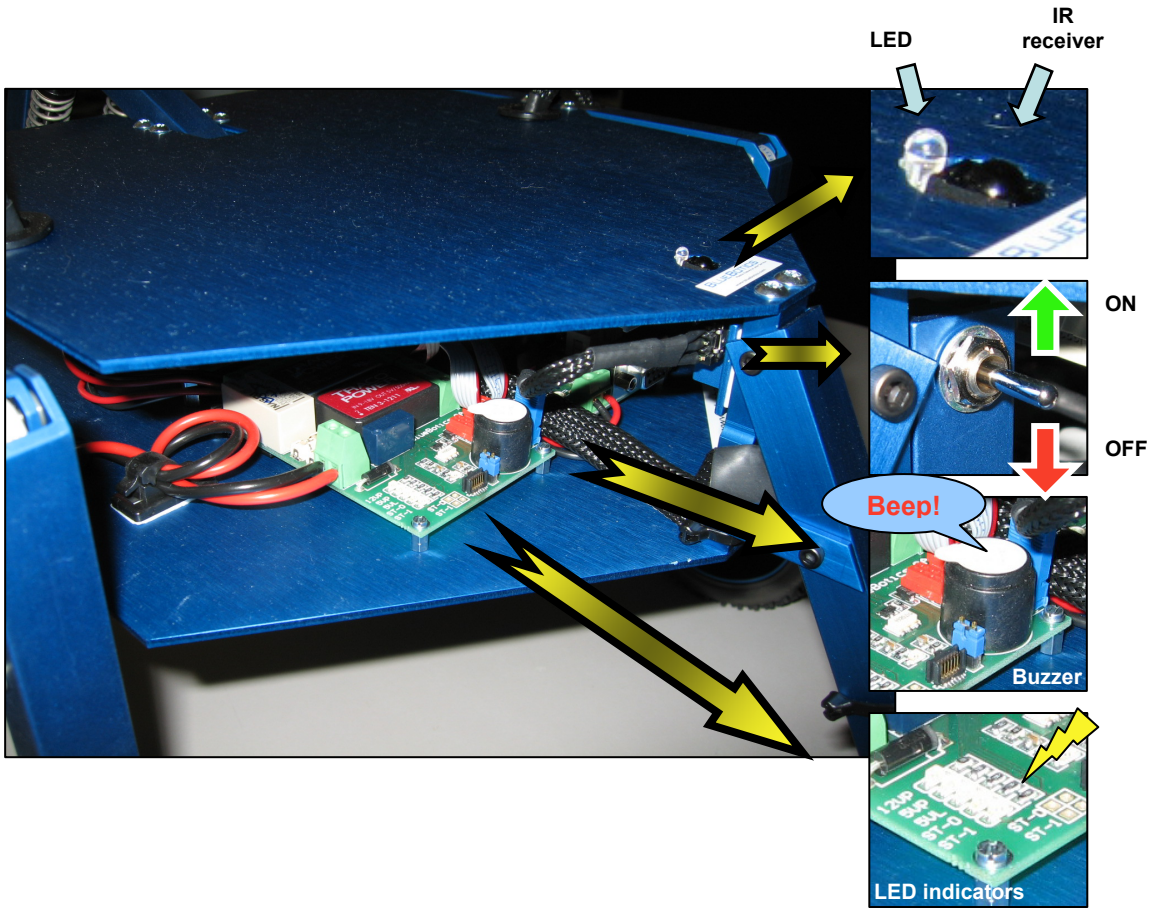

Fig. 2: Position of the IR receiver, the ON/OFF switch, the buzzer and the battery indicator

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Power supply

The power supply module is supervising the battery charge to avoid malfunctions.

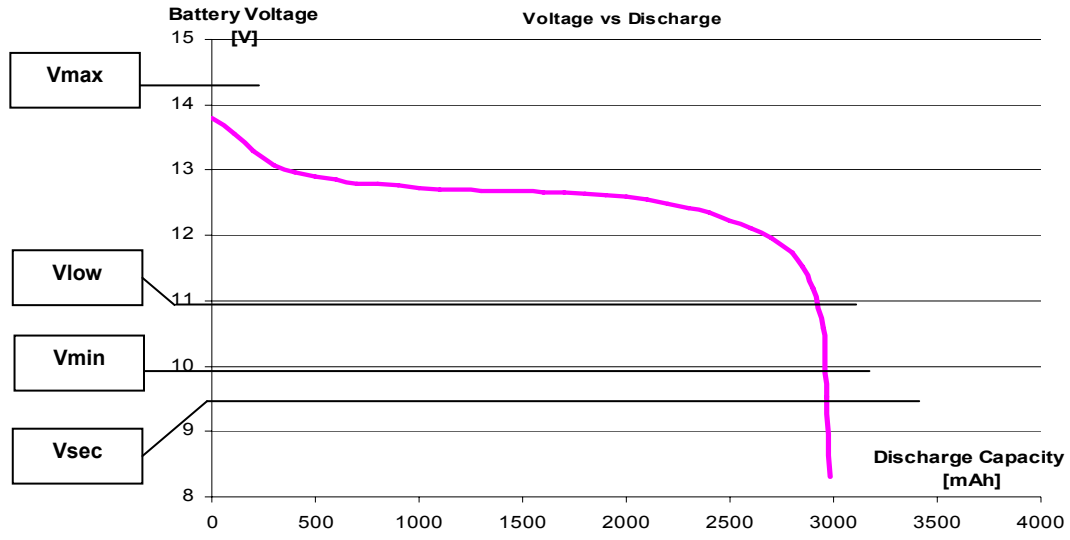
The master controls the power supply module. When the Power Switch is ON (Fig.2), the power supply is connected to the battery and measures its voltage. If the voltage is correct, the robot can be used.

The LEDs placed on the power supply module (see Fig.2) indicate the state of the power supply and of the battery. The buzzer will also act as an audible indication, to inform the user of the state of the system.

The battery supervision is based on four thresholds:

- **Vmax**: Maximum voltage allowing the supply to be used. A battery voltage higher than Vmax causes the power supply to auto-shutdown after a few seconds
- **Vlow**: If the battery voltage drops below Vlow, the battery is quite discharged and has to be replaced as soon as possible.
- **Vmin**: If the user doesn't stop the robot when the battery voltage drops below Vmin, the power to the servos and motors is shutdown. The power supply for the logic remains.
- **Vsec**: If the battery continued discharging below the security level Vsec, it would risk getting damaged. All power supplies are shutdown after a few seconds.

On power on, if the battery voltage is below 11 V, only the logic voltage is enabled and it is not possible to move. The battery pack must be charged or replaced.



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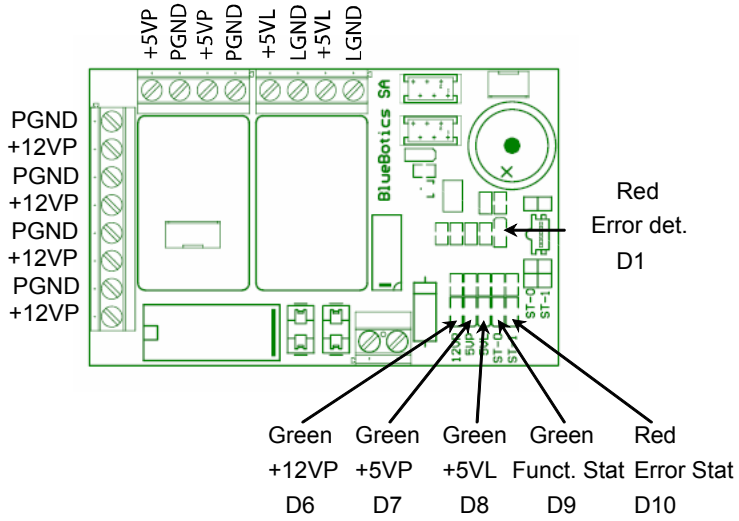
Decoding LEDs and Buzzer

LEDs are placed on the power supply module as can be seen on Fig.2.
D6-D8 show the presence of the corresponding voltage.
D9, D10 indicate the status of the supply.
D1 indicates an error (risk) condition.
The table below shows the decoding.

The top LED, near the IR receiver, shows the state of the robot (standby or powered), and blinks when commands are received.

The Buzzer is used to inform the user of the state of the LED's. The beeps are explained below.

A protective tape on the buzzer avoids the sound to be too loud in a lab. Removing it will greatly increase the acoustic power.



	Vbatt Battery Voltage	Top LED Near IR	D1 Error det	D6 12VP ok	D7 5VP ok	D8 5VL ok	D9 Ok stat	D10 Err. stat	Shutdown type	 after	Comments What to do ?
Standby											
1	>= Vmax	flash ~ 0.5Hz	on	-	-	on	-	blink ~ 3Hz	full	~ 20sec	Vbatt is too high Allow battery to cool down after charging
2	Vmax>V> Vlow	flash ~ 0.5Hz	-	-	-	on	on	-	-	-	Everything OK
3	<= Vlow	flash ~ 0.5Hz	-	-	-	on	blink ~ 1Hz	-	-	-	Voltage is falling, autonomy is low Prepare to stop the robot
4	<= Vmin	flash ~ 0.5Hz	on	-	-	on	blink ~ 3Hz	blink ~ 3Hz	-	-	Minimum voltage reached Stop using the robot and charge the battery
5	<= Vsec	flash ~ 0.5Hz	on	-	-	on	-	-	full	~ 5sec	Security level Shutdown and charge the battery
Powered on											
1	>= Vmax	on	on	-	-	on	-	blink ~ 3Hz	full	~ 20sec	Vbatt is too high Allow battery to cool down after charging
2	Vmax>V> Vlow	on	-	on	on	on	on	-	-	-	Everything OK
3	<= Vlow	on	-	on	on	on	blink ~ 1Hz	-	-	-	Voltage is falling, autonomy is low Prepare to stop the robot
4	<= Vmin	on	on	on => off	on => off	on	blink ~ 3Hz	blink ~ 3Hz	power	~ 40sec	The servos and motors will be disabled Shutdown and charge the battery
5	<= Vsec	on	on	-	-	on	-	-	full	5-40sec	Security level Shutdown and charge the battery

	Vbatt Battery Voltage	Buzzer	Mute if mute is on	Shutdown type	 after	Comments What to do ?
Standby and powered on						
1	>= Vmax	short beeps	force mute off	full	~ 20sec	Vbatt is too high Allow battery to cool down after charging
2	Vmax>V> Vlow	-	-	-	-	All is Ok
3	<= Vlow	1 long beep every 6 sec	force mute off	-	-	Voltage is falling, autonomy is low Prepare to stop the robot
4	<= Vmin	short beeps	force mute off	power	~ 40sec	The servos and motors will be disabled Shutdown and charge the battery
5	<= Vsec	continous beep	force mute off	full	5-40sec	Security level Shutdown and charge the battery

Action	Buzzer
Power ON	2 short beeps
Mute ON	2 short beeps
Mute OFF	1 short beep

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Battery charging

For charging, the battery must simply be connected to the battery charger provided with the robot. This manipulation is easy to execute, but for a longer battery working life, we provide some recommendations:

- If the Shrimp is not used for a while, the battery should be disconnected.
- The battery technology is NiMH (Nickel Metal Hydride). Therefore, the battery should be fully discharged before charging it again to keep a good working capacity.
- A freshly charged battery should be left cooling for about one hour before using it.
- After a long non-working period, a maintenance charge should be done.

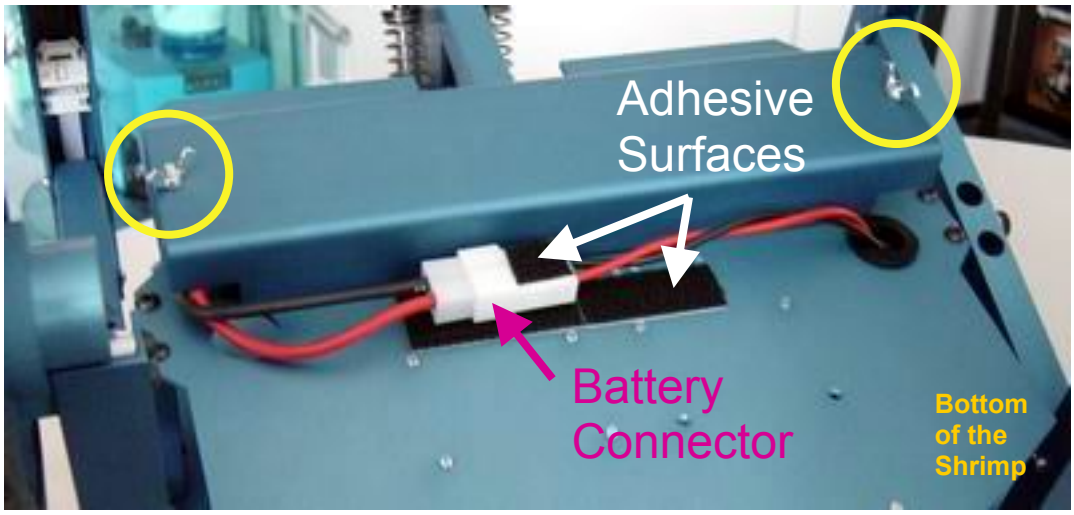

Fig. 3: The battery and its connector

The Shrimp should not be placed upside-down flat on its top when changing the battery pack, as this will bend the cables coming out of the bogies and could damage them.

To remove the battery from the Shrimp, first disconnect it by disassembling the battery connector. Then remove the screws shown in Fig. 3 in the circles and remove the battery cover. Do the reverse process to install a new battery on the rover. Use the adhesive surfaces to fix the connector to the bottom of the Shrimp.

Not respecting the polarity of the battery as well as shortcuts and electric shocks will result in irreversible failures and serious injuries

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Utilization recommendations

The Shrimp is a robust platform, but to avoid problems and to increase its working life, some points must be respected:

- The Shrimp should not be placed upside-down on a flat surface.
- The maximum angles that the Shrimp can manage are 40° pitch (transversal rotation axis) and 40° roll (longitudinal axis). These values can change depending on the weight and placement of the payload.
- It is strongly recommended to overcome an obstacle with the front wheel perpendicular to it. Not respecting this rule will shorten servo working life.
- The Shrimp has been designed to overcome obstacles with a 15 cm maximum height. To ensure good stability while overcoming an obstacle, the payload should be placed such that the center of gravity of the robot is as low as possible.
- The Shrimp is not waterproof. Water damages the motors and the electronic components. It must be used exclusively in dry places.
- The Shrimp is not adapted for potentially dangerous environments such as explosive places.

Manipulation instructions

The Shrimp is a light rover and therefore is not particularly dangerous. Nevertheless one can injure oneself with some elements of the robot. The following points can help avoiding injuries:

- The edges are quite sharp. Pay attention when manipulating the rover to avoid injuring yourself.
- On fig. 5 the locations where one can get easily pinched are shown. Avoid touching these parts, especially when grasping or holding the rover

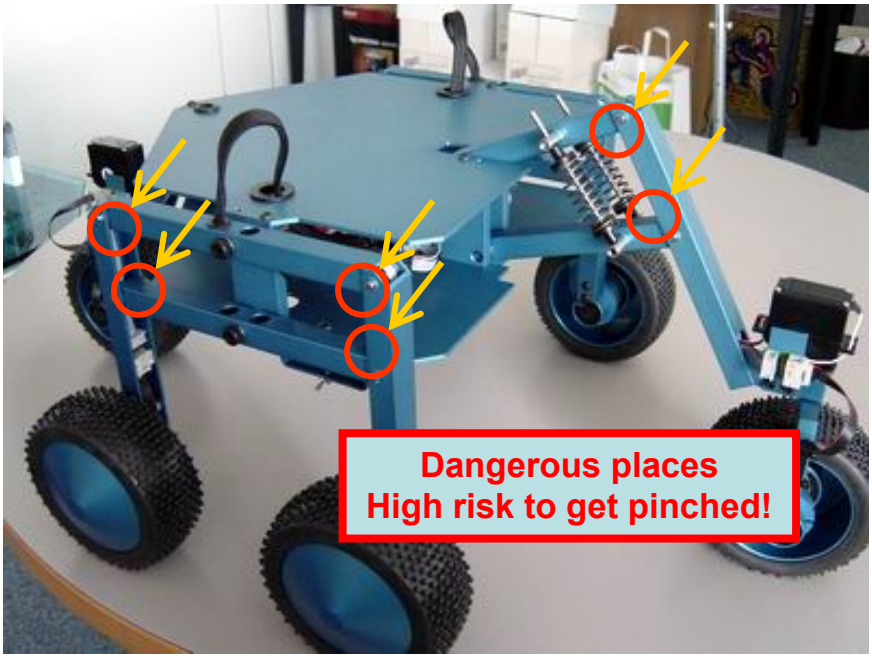

Fig. 5: Injuring risks at some places – beware!

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Shrimp maintenance

- The platform has been designed to avoid regular maintenance.
- If the Shrimp is not used for a longer period of time, the battery should be disconnected.
- A quick check of the whole rover should be done before using it to avoid more significant problems.
- If water accidentally gets on the robot, disconnect the battery immediately and remove the water as soon as possible.

Quick start

To start the robot for the first time:

- Place a charged battery pack into the battery cover and fix it.
- Connect the battery to the cable and fix the connector with the scratch.
- Switch on the main power supply (fig.2).
- Use the remote control to power on the robot and control it.

When finished:

- Stop the robot in horizontal position.
- Power off the robot with the remote control.
- Switch off the main power supply.
- Charge the battery if needed.

Package content

- 1 Shrimp rover with one battery mounted
- 1 battery charger
- 1 supplementary battery 12V NiMH (optional)
- 1 infrared remote controller
- 1 kit with replacement fuses and metric spare nuts
- 1 manual

Specifications

Dimensions (L x W x H)	639mm x 429mm x 278mm
Weight	5,4 kg (with a battery pack)
Turning radius	Can turn in-place
Max stability angles	40° pitch, 40° roll
Payload	max 3 kg
Maximum speed	~ 0.4 m/s
Power consumption	40 W maximum / 20 W standard
Input power	12 V DC / 6 A
Battery	12 V NiMH (10 elements of 1.2 Volt)
DC motors	4.2 W motor
Servos	Futaba S9206

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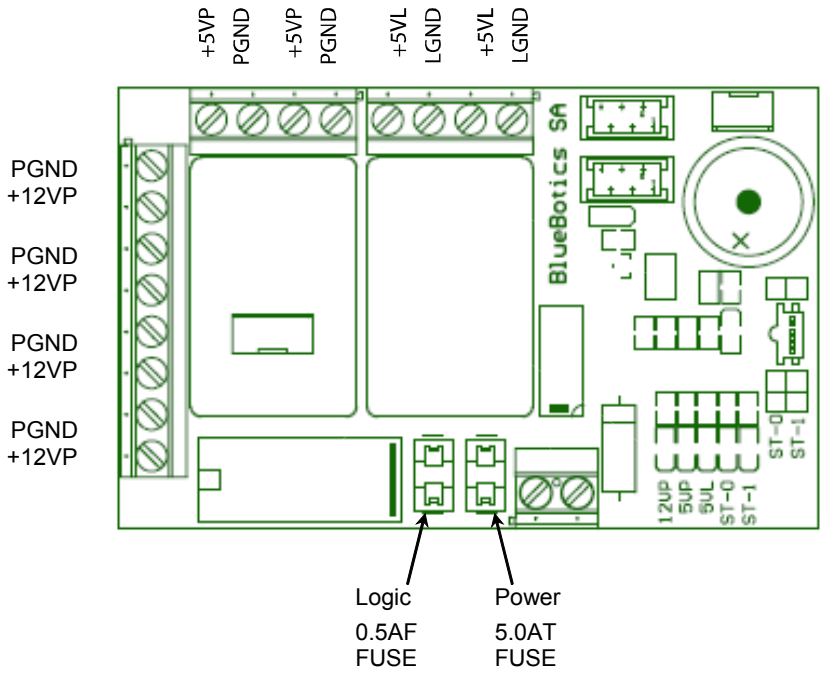
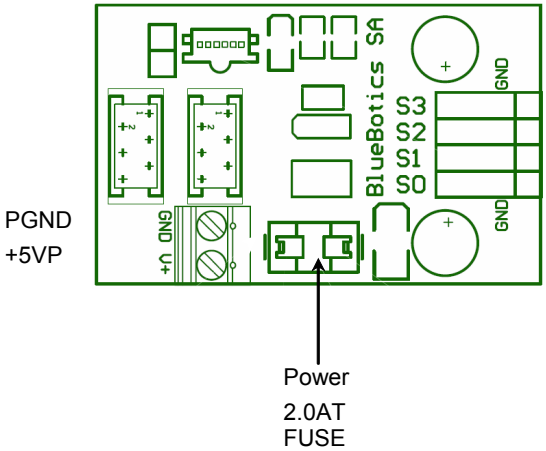
Fuses

Power supply fuses



Servomotors fuses



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Drawings