

# Botronix

## Ranger

### Extensible Mobile Robot

### Description

Ranger is a mobile robot. The platform has two front wheels attached to continuous rotation servo motors. The rear portion of the robot is supported with a nylon ball-castor. The two front wheels and the rear-ball castor form the tripod footprint. Ranger is powered by 6 AA batteries. The batteries are attached to the underside belly of the chassis.

Ranger is equipped with an ATmega164P microcontroller. The ATmega164P is a low-power 8-bit microcontroller that features RISC architecture, Flash, EEPROM, digital and analog I/O, multiple analog-to-digital converter (ADC) channels, timers, PWMs, and serial communication interfaces. One of the serial communications interfaces is connected to a USB transceiver for communications with a personal computer. The ATmeag164P can be programmed via the In-System-Programming (ISP) interface. It can also be programmed through the USB port with the pre-programmed bootloader.

Ranger is equipped with hardware and provisions that allow for modifications and growth. Component solder pads, expansion headers, variable voltage regulators, jumpers and an easily removable and replaceable microcontroller make Ranger an extensible robotic platform.

### Features

- Tripod footprint
- Rigid and strong woven fiberglass chassis
- Popular and simple Differential-Steering locomotion
- Ball bearings in servo motor reduce friction, increased load capacity, and increase longevity
- Rear ball-castor design eliminates mobility skew found on tail-wheel platforms
- Front bumper
- ATMEGA microcontroller
- Freely available C language and assembly microcontroller development tools

- USB
- Microphone
- Buzzer
- Four Status LEDs
- Variable system voltage
- Expansion connectors and add-on hardware mounting holes

### Applications

- Student projects
- Research projects
- Hobby robotics
- Mobile robotics competitions

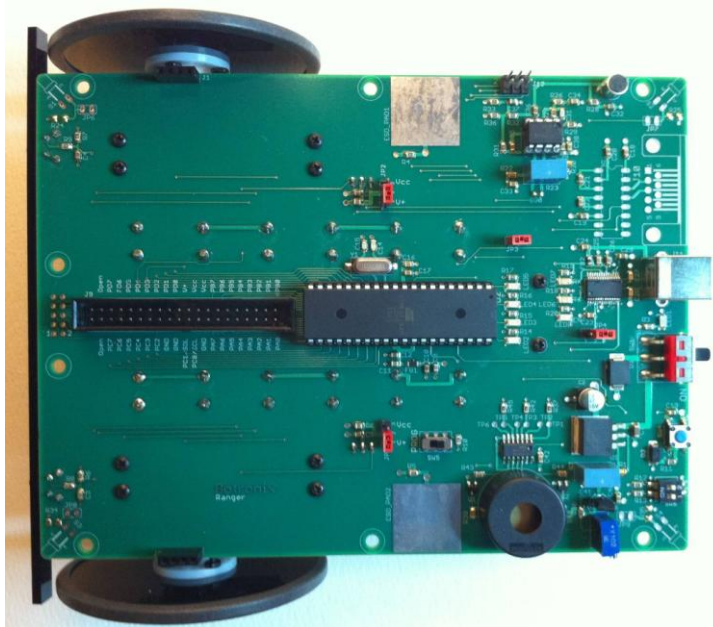


Figure 1 Top of Ranger

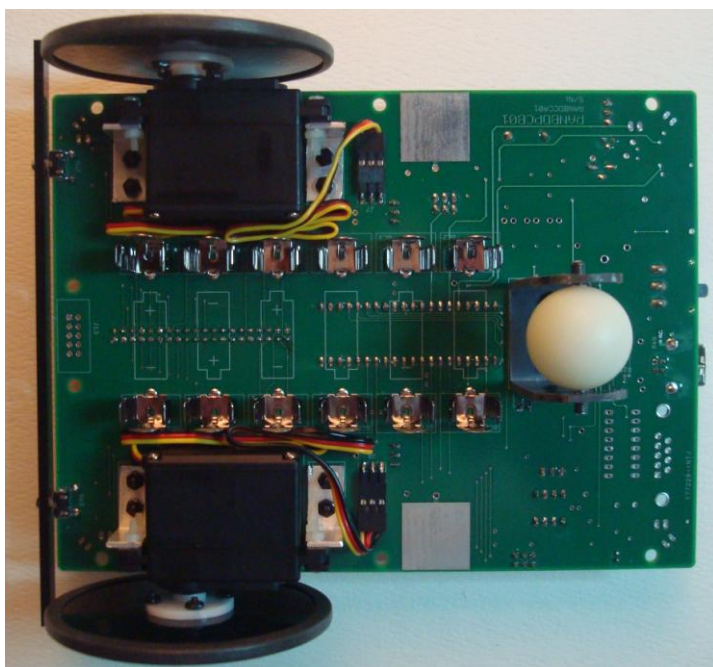


Figure 2 Bottom of Ranger

## Power

Ranger requires 6 AA batteries to operate.

System power is regulated with a linear voltage regulator. The system voltage is variable from 3.3V to 5.0V

## ESD Pads

Ranger has Integrated Circuits that are sensitive to Electrostatic Events. These events can permanently destroy or damage the entire IC or portions of its functionality. To eliminate the potential of a damaging electrostatic discharge, ESD pads are provided. Touching the ESD pad will slowly bring both Ranger and the body to the same ground potential.

## Microcontroller

The microcontroller is the “brain” of Ranger. The Atmel ATmega164P4P is a low-power 8-bit microcontroller based on the AVR RISC architecture. Its features include, but are not limited to...

- Advanced RISC Architecture
- 16K Bytes of In-System Self-programmable Flash program memory
- 512 Bytes EEPROM
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- Two 8-bit Timer/Counters
- One 16-bit Timer/Counter
- Real Time Counter
- Six PWM Channels
- 8-channel, 10-bit ADC
- Byte-oriented Two-wire Serial Interface (I2C)
- Master/Slave SPI Serial Interface
- Programmable Watchdog Timer with Separate On-chip Oscillator
- Power-on Reset and Programmable Brown-out Detection
- Six Sleep Modes
- Power-down Mode: 0.1 $\mu$ A
- Power-save Mode: 0.6 $\mu$ A (Including 32 kHz RTC)

A 16MHz crystal provides the micro's clock.

The micro can be programmed via an external programmer through the ISP header or through the USB connection. Programming over USB requires the factory installed bootloader and that the USB host run programming software that is compatible with the AVR109 protocol.

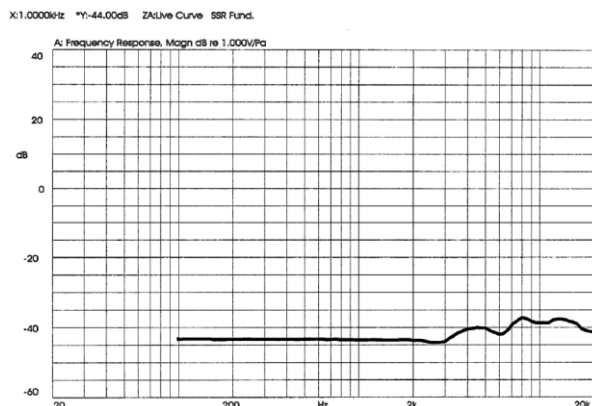
## Sensors

### Front Bumper Switches

Ranger is equipped with a front bumper to sense obstacles. When the bumper makes contact with an obstacle with enough force, one or both of the bumper's tactile switches will be actuated. The tactile switch requires a force of approximately 1 N to depress. The switch signal going back to the microcontroller has a debounce circuit to prevent multiple signal transitions.

### Microphone

Ranger is equipped with an electret condenser microphone. The microphones output electrical signal is biased and amplified prior to inputting to the microcontroller. The amplifier gain is set using a potentiometer. Below is the microphones frequency response curve.



## Effectors

### Propulsion Servos

To propel itself, Ranger has two continuous rotation servos. The servos are used in a skid-steer manner to control the robot's speed and direction. The servo performance specs are listed in the table below.

Electrical Power Voltage	Torque	No-Load Speed*
4.8 VDC	38.8 oz-in	43.4 rpm
6.0 VDC	46.8 oz-in	52 rpm

\*When the load increases, the speed decreases. Some examples of servo loading: added mass to the robot, traveling up an incline, traveling over carpet.

An individual servo control requires only one PWM signal. That signal is provided by the microcontroller.

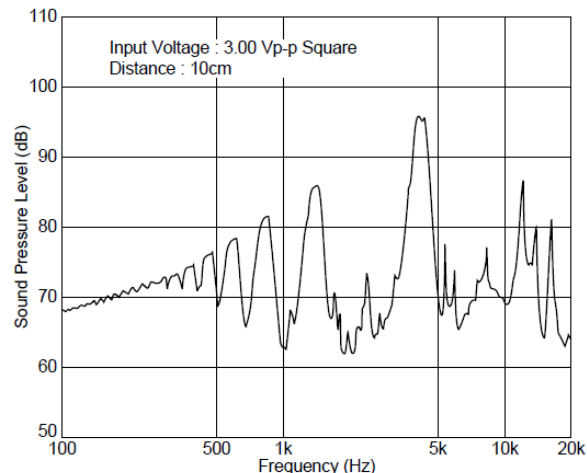
Ranger is appropriate for use on smooth floor surfaces and carpet. The rubber lined wheels obtain traction on smooth as well as rough surfaces. The rear ball-castor spins forward and backward when the robot is in motion. When making turns, the slick, self lubricating ball-castor slides on the floor surface.

### Buzzer

Ranger has one buzzer. It is driven by a push-pull circuit that in turn is controlled by the microcontroller. The user program controls the PWM frequency and thus the frequency of the buzzer's sound. The buzzer is powered separately from the system voltage rail. The voltage level of the buzzer supply is set with a potentiometer. The buzzer's volume is varied by varying the voltage level of the buzzer's power rail. Buzzer specifications are in the table below.

Pressure Level (dB)	Sound Pressure Level (Ref. only) (dB)	Operating Voltage Range
85 min. [3Vp-p, 4kHz, square wave, 10cm]	85 min. [1Vrms, 4kHz, sine wave, 10cm]	25.0 Vp-p max

Below is the buzzer's frequency response curve.



## Status LEDs

Ranger has four user controllable yellow LEDs. They are controlled by the microcontroller.

## Other Interfaces

### USB

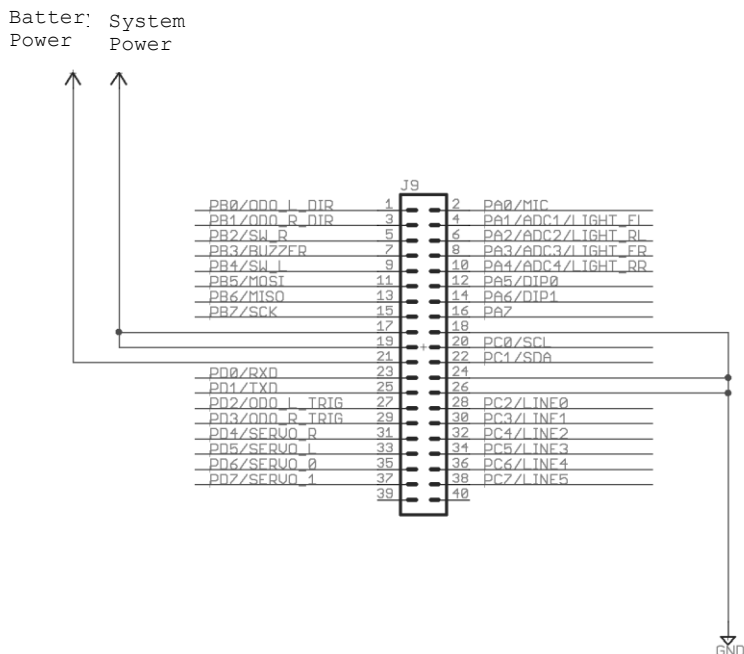
USB connection is made through a USB type B receptacle.

### DIP

A two position DIP switch is connected to the microcontroller.

### Microcontroller Expansion Header (J9)

The expansion header provides access to all the microcontroller I/O pins. In addition to the microcontroller I/O pins, the expansion header has two pins dedicated to system power, one pin dedicated to battery power, and three ground pins. When using these pins to provide power to additional electronics, keep in mind the each pin is rated for one ampere.



### Wheel Encoder Receptacles (J1 & J2)

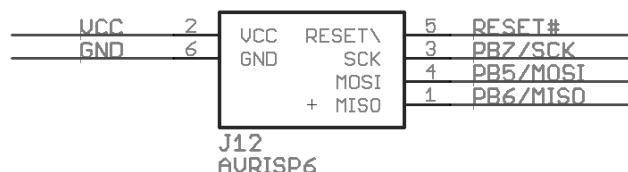
J1 and J2 are provided for future use. They provide power and microcontroller connectivity for plug in wheel encoder sensors. J1 and J2 pin 1 is marked by the square solder pad.

J1 Pin Number	Microcontroller Pin	Description
1	NA	System Power
2	NA	Ground
3	PD3	Edge Transition
4	PB1	Direction

J2 Pin Number	Microcontroller Pin	Description
1	NA	System Power
2	NA	Ground
3	PD2	Edge Transition
4	PB0	Direction

### In System Programming Header (J12)

J12 is the SPI in system programming interface. It is pin compatible with Atmel AVR compatible programmers like the AVR ISP MKII. The pin numbering scheme is odd row and an even row. Pins 1 and 2 are marked on the chassis.



J12 Pin Number	Microcontroller Pin	Net
1	PB6	MISO
2	NA	System Power
3	PB7	SCK
4	PB5	MOSI
5	RESET#	RESET#
6	NA	System Ground

## Line Detector Header (J13) (Not Populated)

Through-hole solder pads for a 0.1" dual row connector are strategically placed at the front of Ranger. See the table below for the pinouts.

J13 Pin Number	Microcontroller Pin	Net
1	NA	System Power
2	NA	System Ground
3	PC2	Line sensor 0
4	PC3	Line sensor 1
5	PC4	Line sensor 2
6	PC5	Line sensor 3
7	PC6	Line sensor 4
8	PC7	Line sensor 5
9	NA	No connect
10	NA	No connect

## Dimensions

Wheel Diameter: 7.6 cm (3.0")  
 Top of Chassis to floor level: 5.1 cm (2.0")  
 Front bumper width: (6.375")  
 Chassis Width: 13.4 cm (5.275")  
 Chassis Length: 18.0 cm (7.10")

## Light Sensors (Not Populated)

Ranger has solder pads for light sensors at all four corners of the chassis. A resistor is placed in series with the sensor, forming a voltage divider. The voltage can be converted by the microcontroller's ADC for use by the user software application. A jumper must be installed to make the connection back to the microcontroller. A schematic of the light sensor circuits is provided below. Vcc is the system power supply rail.

