

# Robotic Development Kit



Powered using ATMEL  
technology

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# System Overview

The Robotic development kit Consists of:

- Robot
- Remote Controller
- IR-pod
- Base Station
- Robot – Controller PCB
- Remote – PCB
- RF-ID Tags
- RFID-Ball
- Ball-Scoop

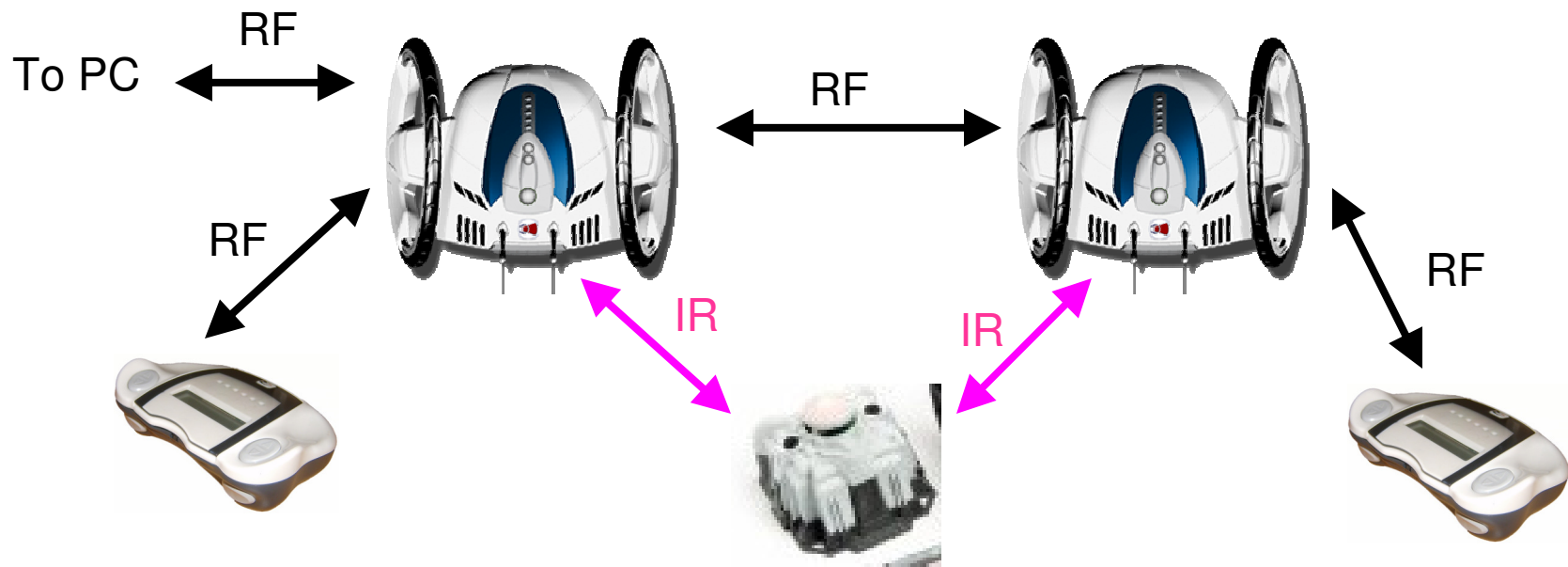


## *System Overview*

### **System Communications**

Robots and remotes can communicate to each other via RF, while the robots can communicate to the base stations via IR. The RF-signal strength can be used as a rough indication to distances between devices.

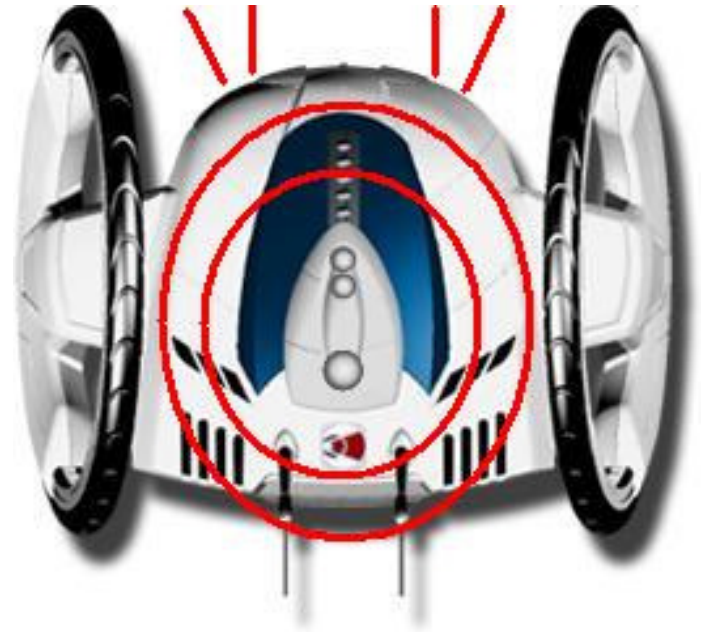
All RF communications can be viewed on a PC by connecting it to a robot's USB interface, and configuring the robot as a RF-sniffer



## *System Overview*

### **System IR Emitters**

The robot is equipped with 8x IR emitters. Six of these emitters are spaced so that an even IR emission is achieved 360deg around the robot. This enables the robot to communicate with base stations regardless of its orientation, and be 'detectable' by other robots



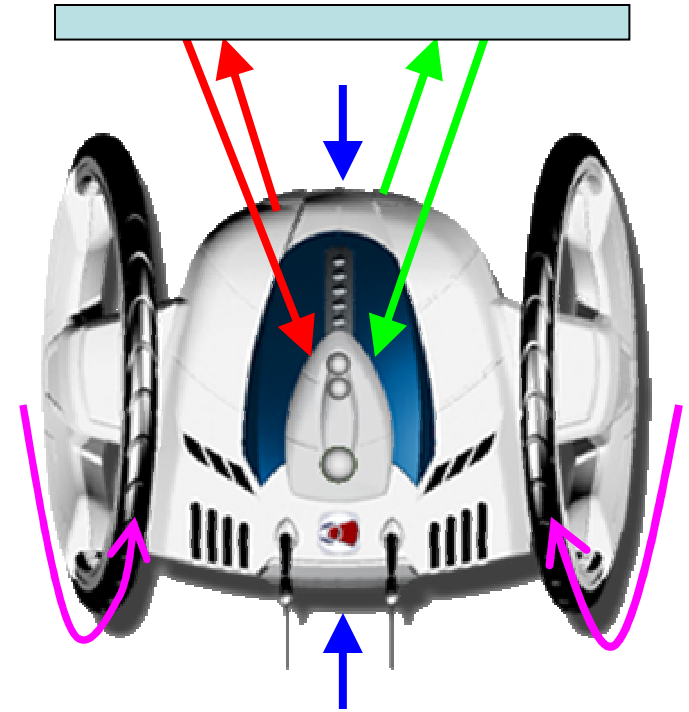
The base station is also equipped with 6 IR emitters to achieve a 360deg IR emission. The IR can be transmitted at 3 signal strengths enabling the robot to do range calculations on the received signal to determine a approximate distance to the base station

The system can handle up to 4x Robots and 2x base stations without IR interference

## *System Overview*

### **Robot Obstacle Sensors**

The robot is equipped with 2x IR emitters as 'head-lights'. Obstacles are detected in various zones by detecting the reflected IR beams. \* \*



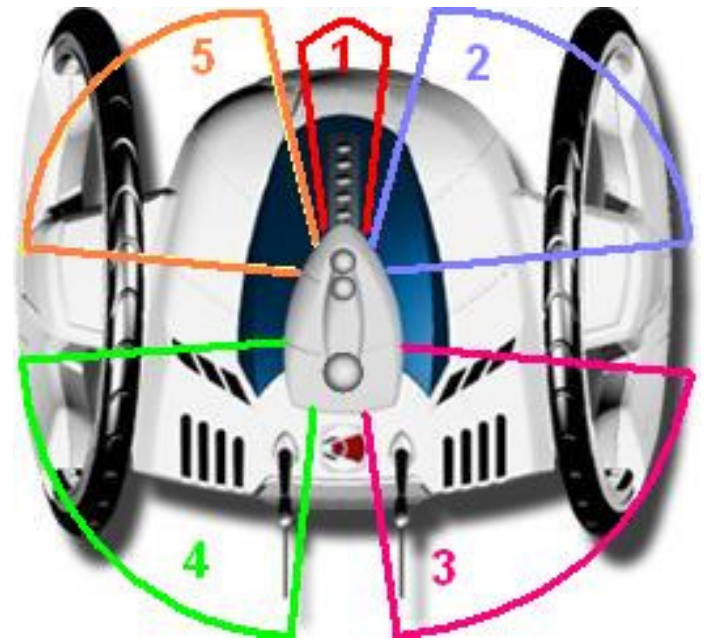
In addition, each motor is equipped with current monitoring enabling the robot to detect when excessive currents are being drawing by the motors, and thus identifying a stuck or obstructed wheel due to an obstacle, \* enabling the robot to take corrective actions

A front and rear bumper also provides feedback when pressed \*

## *System Overview*

### **Robot IR Sensors**

The robot is equipped with 5x IR receivers which enable the robot to get orientation and location information regarding other robots and base stations. It is also used for obstacle detection and decoding range information received from base stations



Multiple zones and RF communication enable the robot to orientate and position itself relative to other robots and can be used for automotive behavior like following another robot, circling a robot/Base Station, moving to the robots left and facing forward, or auto-shooting it as it was used in the Robonii action game application.

## *System Overview*

### **Robot RFID**

RFID tags can be detected and decoded when located beneath the robot. This enables the robot to identify specific locations, or to be aware that it is in possession of an object like the RFID ball



One of the five games in the Robonii Action Games pack requires 2 teams to fight for possession of the ball in order to score. Teams can shoot each other when in possession of bullets to deactivate the other robot for a short while, or use booby-traps against the opposing team. These can be collected from specific game objects at random intervals in the game.





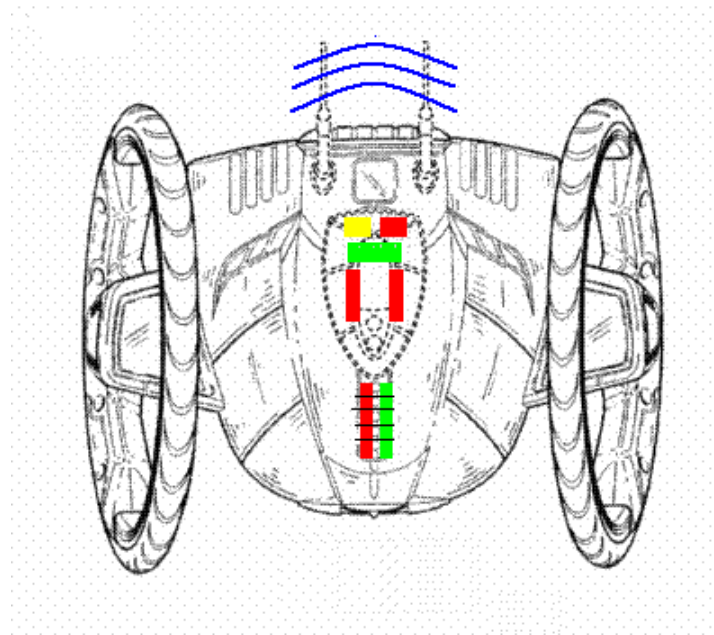
## *System Overview*

# **Audio & Visual communicators**

**The robot is equipped with 15x LED's and 1x audio loud speaker and amplifier**

**The base station has 3x LED's and 1x bicolor LED that is controlled from the robot.**

**All other visual communication is done via the robots remote**



## *System Overview*

# Remote

The remote has 6 buttons usually used to control the robot.

In addition the remote has 6x LED's and an LCD with 64 segments to display state information.

The remote has a cavity under the transparent cover where a 'status-card' can be placed that shows what each symbol indicates

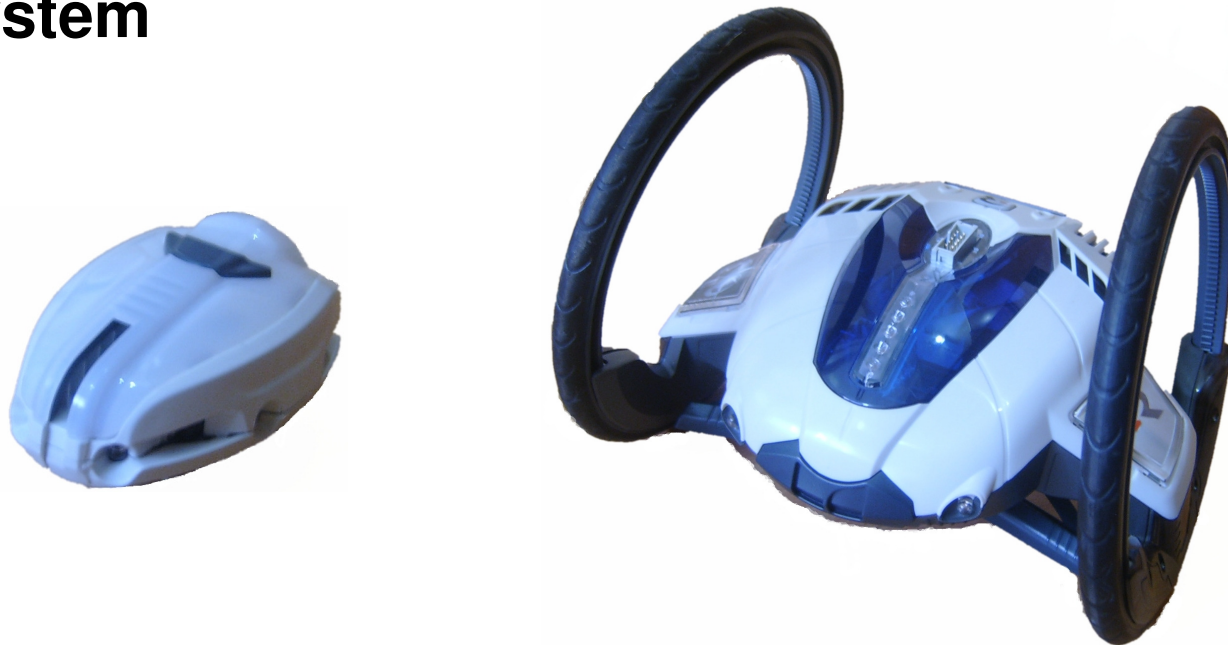


## *System Overview*

# IR-Pod

**The IR-pod plugs into the robots specialized port and forms the heart of the IR direction and orientation system.**

**The robots specialized port has multiple interfaces to the robots controller and can be used to add 'gadgets' into the system**



# Technology Overview

The robotic development kit was born over a period of 4 years by combining technology from multiple development kits. These include ATMEL development kits for:

- Zigbee
- RFID (125KHz)
- Programmable USB slave devices
- AVR- ATxMega (8-bit MCU)
- AVR- ATtiny

## *Technology Overview*

# **Communication**

RF packets are used to communicate between Robots, Remotes and PC's. All RF devices are FCC and ICASA approved.

Bidirectional IR is used to communicate to Base-stations

The Robonii project used IR and RF to detect obstacles, relative location, orientation and distance to other robots and Base-stations.

## *Technology Overview*

### **Development tools**

AVR-Studio is an **I**ntegrated **D**evelopment **E**nvironment software package that can be used for the AVR MCU's and can freely be downloaded from ATMEL's website

The robot-PCB comes preloaded with a boot-loader and can be programmed via the USB port without any additional tools

All the MCU's used in the Robotic development kit can be programmed and Debugged using the MKii and JTAG MKii available from ATMEL

Individual dev-kit components

## Robot

- ATxMega128
- RF (AT86RF230)
- RFID (U2270B)
- 10x LED's
- 2x Buttons (Bumpers)
- USB (Programmable AT90USB82)
- Audio Amplifier with Speaker (NCP2820)
- 2xDC-motors
- 2x IR Emitters
- Integrated Battery enclosure with power switch
- External interface with I2C and 3xADC/GPIO
- Program via USB or External PDI interface
- On-Chip Debug via JTAG or PDI interface

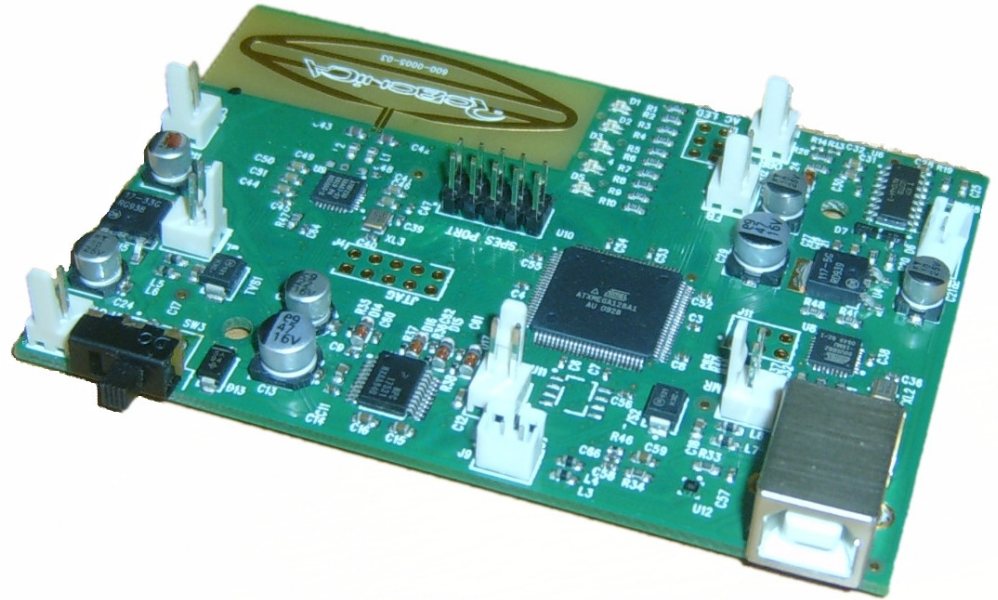




Individual dev-kit components

## Robot-PCB (1)

- Power Supply
  - Supply Voltage: 6.2V – 9V
  - 3.3V available from PCB
  - 5V available from PCB
  - Power switch
- ATxMega128
  - 8 Bit MCU running at 31MHz
  - 128KB flash, 8K SRAM
  - 2KB EEPROM
  - JTAG and PDI interface available via connector
- RF (AT86RF230)
  - 2.4GHz RF bi-directional interface with PCB-Antenna
  - Range +/- 40m
  - Running at 16MHz
  - Connected to ATxMega via SPI interface
  - Can be used with ATMEL Zigbee stack
- RFID (U2270B)
  - RFID reader/ Writer
  - Suitable for Manchester and Bi-phase modulation
  - RFID-Antenna installed in Robot and can easily be manufactured at home

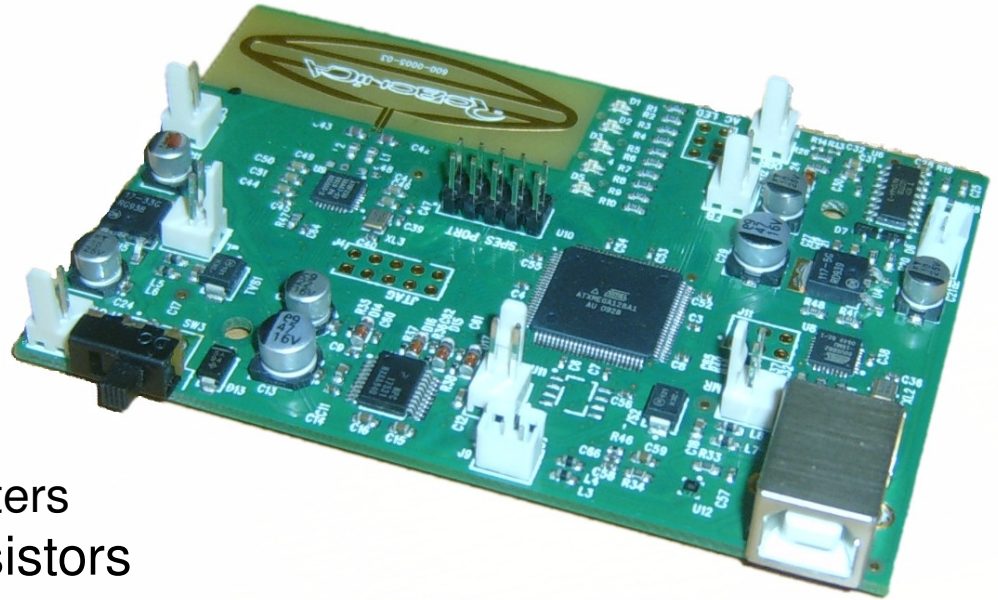




Individual dev-kit components

## Robot-PCB (2)

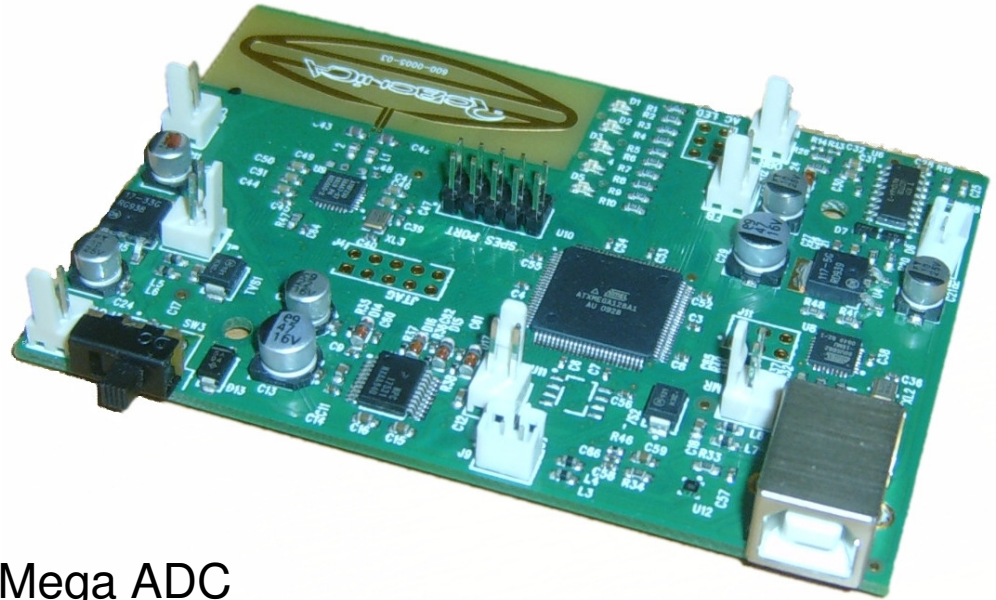
- 10x LED's
  - 5x Red
  - 5x Green
- 2x GPIO
  - Used for Robot bumpers
  - Connects via 2x 2Pin Connectors
- 2x GPIO buffered via 330R resistors
  - Used to drive IR emitters
  - Connects via 2x 2Pin Connectors
- USB (Programmable AT90USB82)
  - Implemented as USB slave device
  - Used as USB – serial converter
  - Programming interface available
- Audio Amplifier (NCP2820)
  - ATxMega can produce sound by generating PWM signal that is transformed into an Analogue voltage before being fed to the amplifier
  - Connected to Robots 1W Speaker



Individual dev-kit components

## Robot-PCB (3)

- 2xDC-motors control
  - Using MPC17531
  - Dual H-Bridge Motor driver
  - Power save mode
  - Protection circuitry
  - Stall current detection via ATxMega ADC
- Interface with I2C and 3xADC/GPIO
  - Usually connected to IR-Pod



Individual dev-kit components

## Remote

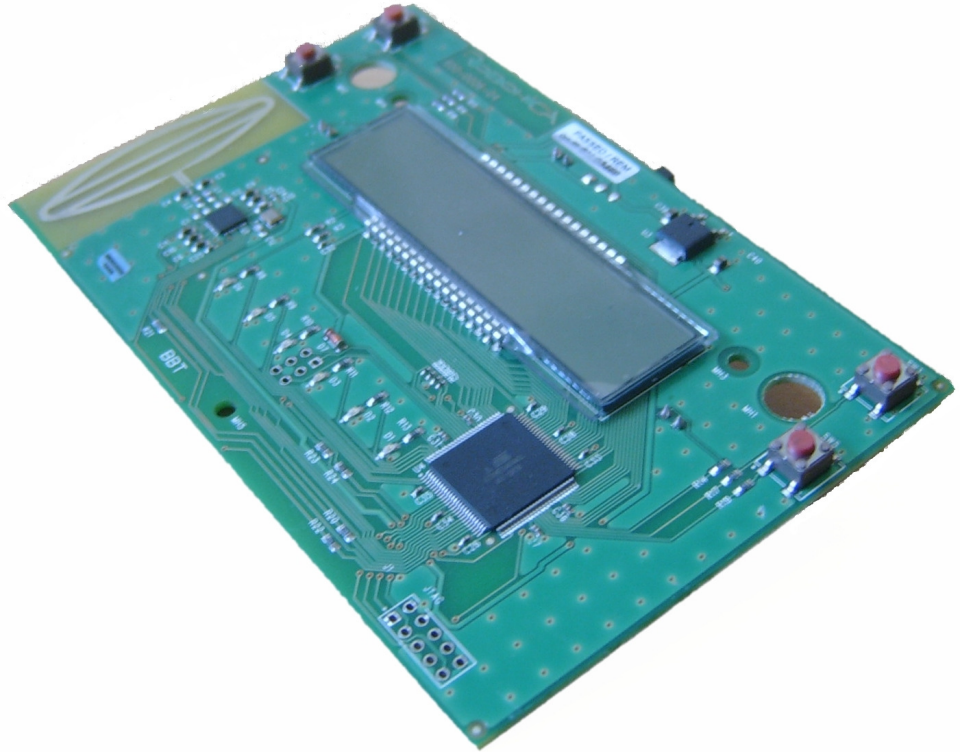
- ATxMega64
- RF (AT86RF230)
- 6x LED's
- 6x Buttons
- LCD with 64 Symbols
- Integrated Battery enclosure and power switch
- On-Chip Debug via JTAG or PDI interface
- Transparent Symbol description card holder



Individual dev-kit components

## Remote-PCB (1)

- Power Supply
  - Supply Voltage: 4V – 9V
  - 3.3V available from PCB
  - Power switch
- ATxMega64
  - 8 Bit MCU running at 16MHz
  - 64KB flash
  - 4K SRAM
  - 2KB EEPROM
  - JTAG and PDI interface available via connectors
- RF (AT86RF230)
  - 2.4GHz RF bi-directional interface with PCB-Antenna
  - Range +/- 40m
  - Running at 16MHz
  - Connected to ATxMega via SPI interface
  - Can be used with ATMEL Zigbee stack
- 4x Buttons on PCB
- 2x GPIO connectors
  - Connected to Remote Trigger buttons

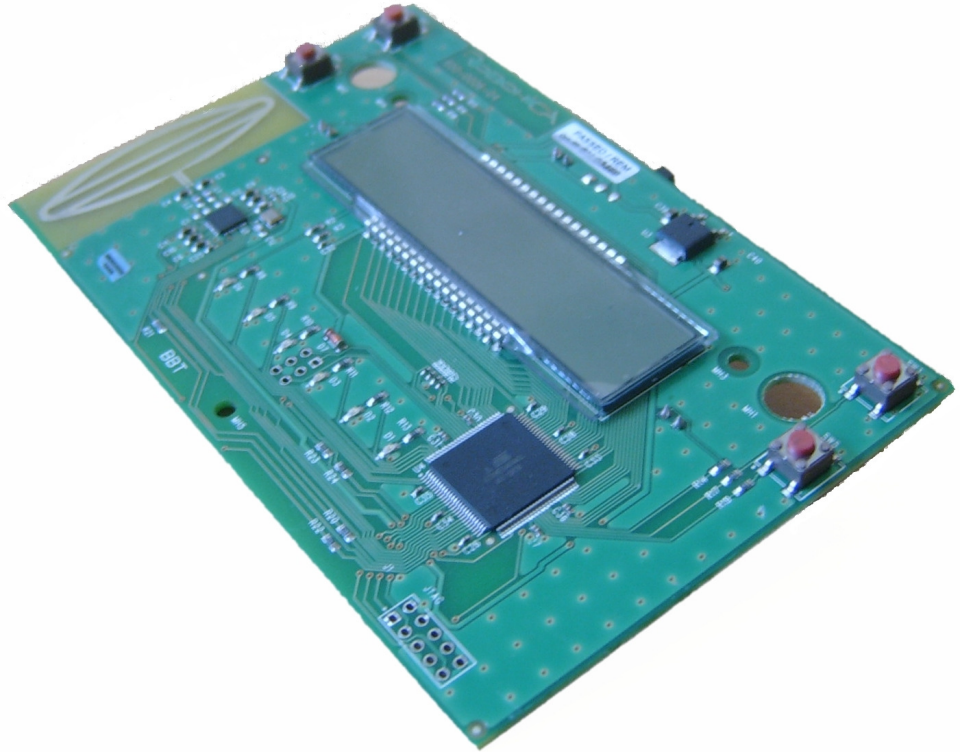




Individual dev-kit components

## Remote-PCB (2)

- USART
  - USART available on connector
  - USART logic 3.3V
  - Protected by series 33R resistors
- SMD LED's
  - 2x Yellow
  - 2x Red
  - 2x Green
- LCD – 64 Symbols



Individual dev-kit components

## IR Pod

- ATtiny 48
- 6x IR emitters (360deg)
- 4x IR Receivers (360deg)
- 1x IR Receiver (5deg)
- 5x LED's
- I2C interface
- Programming interface
- Usually connects to Robot



Individual dev-kit components

## **IR Pod - PCB**

- ATtiny 48
  - 8bit MCU
  - 4K Flash
  - 64 Bytes EEPROM
  - One Wire debug
- 6x IR emitters (360deg)
  - Each emitter emits at a 60deg angle
  - Emitters controlled as single emitter
- 4x IR Receivers (360deg)
  - Each receiver connects to individual Input on MCU
  - GP18C38BA
- 1x IR Receiver (5deg)
  - 'Gun' receiver reception angle limited by enclosure
  - GP18C38BA
- 2x LED 3mm
  - Red
- 3x SMD LED's
  - Red, Green, Yellow
- Programming interface via connector



Individual dev-kit components

## Base Station

- ATtiny 48
- 4x IR Receivers (360deg)
- 5x LED's
- 6x IR emitters (360deg)
- IR Emitters can transmit at 3 different IR levels
- Programming interface
- Integrated Battery enclosure and power switch
- Unit consists of 2 PCB's (MCU-PCB, LED-PCB)





Individual dev-kit components

## Base Station – *MCU* PCB

- ATtiny48, 8bit MCU
  - 4K Flash, 256B SRAM
  - 64 Bytes EEPROM
  - One Wire debug
- Programming interface via connector
- VCC = 3.8V
  - Power supply 2.2V – 3V
  - Use step-up V-Regulator to obtain 3.8V
- Connector to 4xGPIO
  - Usually connected to IR Receivers on LED-PCB
- Connector to 5xGPIO via 91R resistors
  - Usually connected to LED's on LED-PCB
- 1xOutput from driving transistors via connector
  - Current limits can be set at 3 levels
  - Usually connected to IR emitters on LED-PCB
  - Controlled from 2 MCU outputs



Individual dev-kit components

## Base Station – *LED PCB*

- 6x IR emitters (360deg)
  - Each emitter emits at a 60deg angle
  - Emitters controlled by single IO single emitter
- 4x IR Receivers (360deg)
  - Each receiver connects to individual Input on MCU via connector
  - GP18C38BA
- 5x SMD LED's
  - 2xRed, 2xGreen, 1xYellow

