

# HappyGem Prototype (v0.1)

## Notes

### **Microcontroller / Transceiver**

The ATmega128RF microcontroller with integrated IEEE 802.15.4 transceiver was used because we were familiar with the AVR microcontrollers, and because it's their only  $\mu\text{C}$  with an integrated transceiver.

### **JTAG**

Two unused pins on the JTAG connector has been repurposed as pins for USART serial communication. This enables debugging by printing strings to the USART, which can be read by a terminal software on your computer.

The four pins on the  $\mu\text{C}$  related to JTAG is also used for other purposes (battery sensor, buttons and microphone input). This is rather clumsy, because to use these pins, the JTAG must be disabled, and if the JTAG is disabled, the chip can not be programmed. This was solved by disabling the JTAG 3 seconds after reset. To program the device, the programming must be initiated right after pushing the reset button.

### **LED drivers**

The design uses 3 LED drivers, which is basically a shift register controlling a constant current regulator. This means that the LEDs can be set to either on or off. To get more colors, the LED drivers must be PWM'ed, which must be done manually by software in the  $\mu\text{C}$ . This is rather processor intensive, and it's not possible to achieve a satisfying amount of brightness levels.

A mistake has been made here: The LED's should have their anode connected to the power supply (VDD), and their cathode connected to the LED drivers. To the connection to ground must be etched away on the PCB, the LEDs mounted the other way around, and a wire must be pulled from VDD to every LED on the board.

## **Microphone**

The microphone circuit is absolutely bogus. The voltage variations are very small, so it's probably impossible to get anything useful out of it. An amplifier is needed.

## **PCB Antenna**

The PCB antenna is one designed by Atmel, and used in for instance in the AVR Raven kit. The performance of this antenna is quite decent, achieving about 200m range in optimal conditions. For more information about the antenna, see:

<http://www.atmel.com/Images/doc8095.pdf>

## **Buzzer**

The buzzer works fine. It's connected to the transmit pin of USART1, as it was thought that maybe this could help with bit-banging a signal. But this hasn't been tested. Bit-banging through GPIO was used instead. It would probably have been a better idea to connect it to a timer/counter output instead. The buzzer was also not very useful to us.

## **Power supply**

A fixed 3.3V volt boost regulator IC was used. Later it was found that a variable boost regulator would have been cheaper (despite requiring two additional resistors to set output voltage). So unless space is very tight, I would recommend going for that.

## **Battery measurement**

To let us read the battery voltage, a voltage divider formed by the resistors R5 and R6 reduces the voltage. The maximum voltage of the two batteries should be 3V, while the maximum voltage of the ADC is 1.8V.

The bad thing about this design is that it's always drawing a small current from the batteries. With the values indicated in the schematic, it should be less than 12 $\mu$ A, but with a couple extra components we could have made it possible to shut down the voltage divider when

we're not using it.

### **Buttons**

The buttons on the side of the device is mounted to ground through the same via as the neighboring LED. This poses some issues when hacking around the mistake that was made with the LEDs. The buttons are also rather small, and hard to notice.

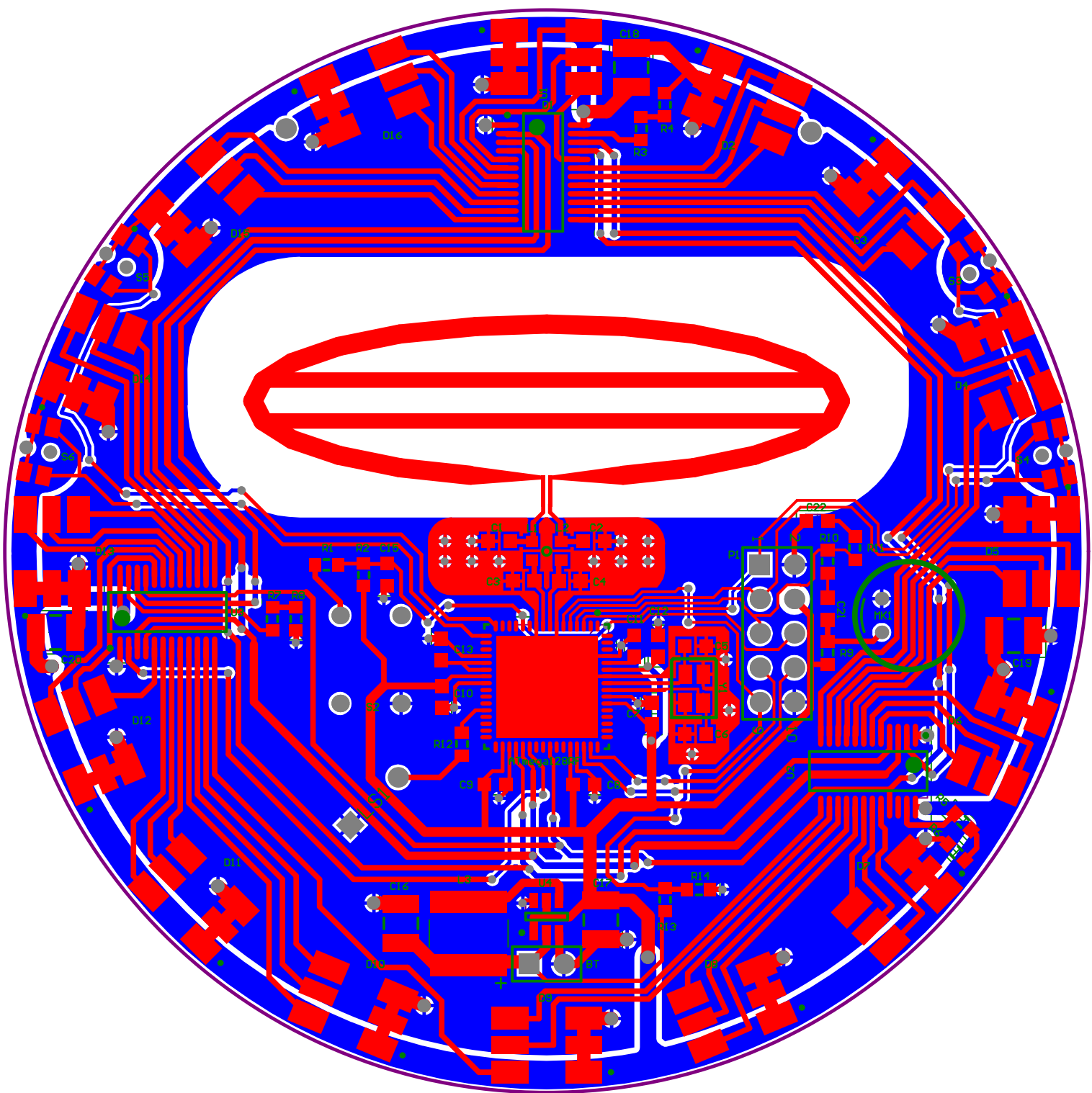
### **Reset**

The reset button circuit is perhaps a bit overkill. It was lifted straight from one of Atmel's application notes.

### **PCB**

The PCB is two layer, to save on cost. The back layer is mostly filled with a ground fill layer. Around the edge of the back layer is a big trace that carries power to the LED drivers (and should also have been connected to the LEDs). The PCB was not designed with unintentional EM radiation in mind.





| Qty | Part                          | Description        | Des.    | Digi URL  | Price (1)        | Total          |
|-----|-------------------------------|--------------------|---------|---|------------------|----------------|
| 1   | ATmega128RFA1                 | MCU/RF             |         | <a href="http://search.digikey">http://search.digikey</a> | \$9.46           | \$9.46         |
| 1   | 644-1093-1-ND                 | 16Mhz XTAL, 8pF    | Y1      | <a href="http://search.digikey">http://search.digikey</a> | \$2.30           | \$2.30         |
| 2   | 445-5043-1-ND                 | Cap 8pF            | C5,C6   | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.20         |
| 2   | 445-1485-1-ND                 | Ind 2.7nH          | L1,L2   | <a href="http://search.digikey">http://search.digikey</a> | \$0.15           | \$0.30         |
| 4   | 445-5011-1-ND                 | Cap 1.2pF          | C1-C4   | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.40         |
| 7   | 478-1251-1-ND                 | Cap 1uF            | C7-C13  | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.70         |
| 1   | AS1325-BSTT-33CT-ND           | 3.3V Volt Reg      | U4      | <a href="http://search.digikey">http://search.digikey</a> | \$2.80           | \$2.80         |
| 1   |                               | 10uH Ind           | L3      | <a href="http://search.digikey">http://search.digikey</a> | \$0.34           | \$0.34         |
| 5   |                               | 22uF Cap           | C16-C20 | <a href="http://search.digikey">http://search.digikey</a> | \$0.53           | \$2.65         |
| 16  | CLV6A-FKB-CK1P1G1BB7R3R3CT-ND | RGB LED            | D*      | <a href="http://search.digikey">http://search.digikey</a> | \$0.75           | \$12.00        |
| 3   | 296-23916-1-ND                | 16-bit LED Driver  | U1-U3   | <a href="http://search.digikey">http://search.digikey</a> | \$1.60           | \$4.80         |
| 1   |                               | Buzzer             | LS1     | <a href="http://search.digikey">http://search.digikey</a> | \$0.85           | \$0.85         |
| 1   |                               | 1k 0603 Res        | R12     | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.10         |
| 1   |                               | Reset Btn          | S2      | <a href="http://search.digikey">http://search.digikey</a> | \$0.20           | \$0.20         |
| 1   |                               | 330R 0603          | R12     | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.10         |
| 1   |                               | 10k 0603           | R2      | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.10         |
| 1   | 478-1239-1-ND                 | Cap 100nF (reset)  | C15     | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.10         |
| 4   |                               | Side Push Btn      | S3-S6   | <a href="http://search.digikey">http://search.digikey</a> | \$0.74           | \$2.96         |
| 1   |                               | AAA battery holder | BT      | <a href="http://search.digikey">http://search.digikey</a> | \$1.03           | \$1.03         |
| 1   |                               | 100k - R13         | R13     | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.10         |
| 1   |                               | 150k - R14         | R14     | <a href="http://search.digikey">http://search.digikey</a> | \$0.10           | \$0.10         |
|     |                               |                    |         |   | <b>Total(1):</b> | <b>\$41.59</b> |