Beacon Atom Hardware Design Analysis

Seeed Studio EE

2012/12

Seeed EE
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Beacon Atom Hardware Design Instruction

Design Objectives

1. Provide hardware support for Atom.
2. Capable of USB Program update function.
3. Capable to receive and convert screen flash signal to digital signal.
4. Have a standard Bee interface, convenient to connect RFBee and XBee.
5. Have a standard Grove interface, convenient to use Seeed Grove modules.
6. Have indicator function.
7. Have a buzzer.
8. Capable to manage the power supply in the interface.
9. Capable to charge Lithium battery.
10.

Hardware Design Scheme

1. The system adopts Atmel 32U4 as the main control chip. This chip has a built-in USB-to-Serial Port module. Under the same condition of efficiency and Flash Volume, the price is superior to Atmega328P.
2. Wireless communication adopts our existent RFBee module, whose communication distance reaches 100m, meets design specifications.
3. Light sensor circuit adopts photistor to test screen flash; and the back-end adopts Schmitt trigger to tune waveform.
4. Equipped with standard Bee interface socket. Communication interface is serial port.
5. Equipped with 3 Grove interfaces, which are classified by functions, i.e. IIC interface, PWM output port, and AD conversion interface.
6. Equipped with 3 indicators, whose functions are: power (blue & red), charge (green & red), and user LED (green & red).
7. Buzzer adopts active buzzer, whose power-line voltage is 3.3V.
8. Adopting P-MOSFET, the system is capable of cutting external power source.
9. The system is working at 3.3V. It has a 300mAh Lithium battery. Charge management IC adopts CN3065, which is used in our products. It takes about 30 minutes to get fully charged with USB.

Detailed Hardware Design Instruction

This part describes the circuit structures in details.

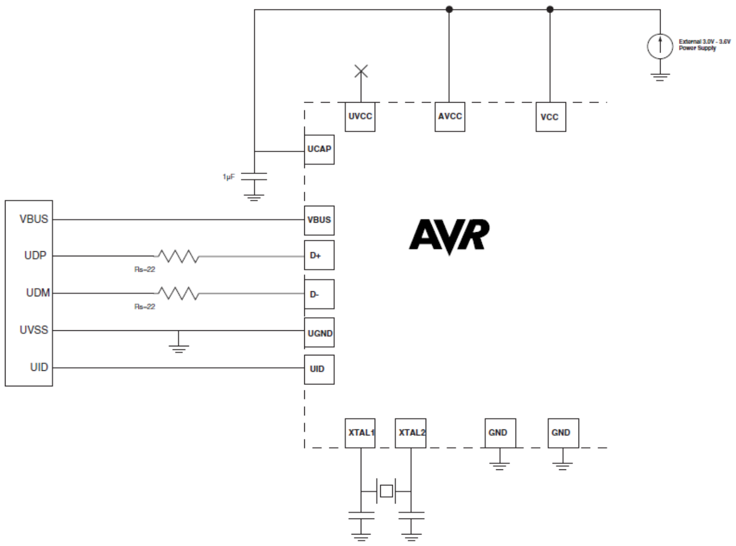
MCU

1）The whole system adopts 3.3V voltage. As to 32U4, please refer to design documents: AVR UVCC pin is hanging, differing from 5V system application.

BEACON ATOM pin map					
32U4					
Pin Num	Pin Net	assignment	Pin Num	Pin Net	assignment
1	PE6/D7/GD02	Grove power control	23	GND	GND
2	UVCC	3.3V	24	AVCC	3.3V
3	D+	USB date	25	PD4/A6/D4	Grove PWM pin2
4	D-	USB date	26	PD6/A11/D12	Light sensor input
5	GND	GND	27	PD7/A7/D6	Battery level LED
6	UCAP	3.3V	28	PB4/A8/D8/GD00	Power control
7	VBUS	5V	29	PB5/A9/D9	Grove PWM pin1
8	D17/PB0/RXLED	D3 RX statue	30	PB6/D10/SS	Not connect
9	D15/PB1/SCK	Not connect	31	PD6/D5	KEY detect
10	D16/PB2/MOSI	Not connect	32	PC7/D13	User LED D4
11	D14/PB3/MISO	Not connect	33	GND	GND
12	PB7/D11	User LED D4	34	VCC	3.3V
13	RESET	Reset	35	GND	GND
14	VCC	3.3V	36	PF7/A0	J6 AD input
15	GND	GND	37	PF6/A1	J6 AD input
16	XTAL1	16M crystal	38	PF5/A2	Battery measures
17	XTAL2	16M crystal	39	PF4/A3	buzzer control
18	PD0/SCL/D3	J4 IIC interface	40	PF1/A4	RFBEE power control
19	PD1/SDA/D2	J4 IIC interface	41	PF0/A5	Not connect
20	PD2/RXI/D0	RF Bee interface	42	AREF	Not connect
21	PD3/TXO/D1	RF Bee interface	43	GND	GND
22	PD5/TXLED	D1 TX status	44	AVCC	3.3V

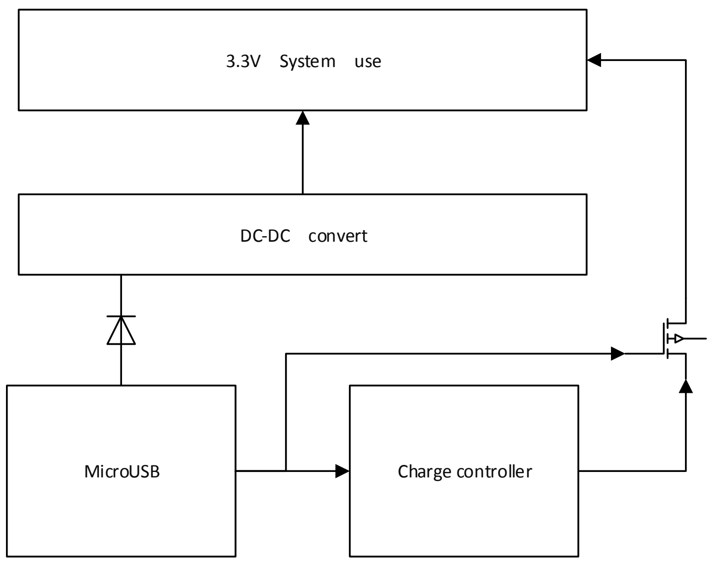
2）The bootload of 32U4 is the same as that of Arduino Leonardo by default.

Typical Self powered application with 3.0V to 3.6 I/O



Power Supply Method

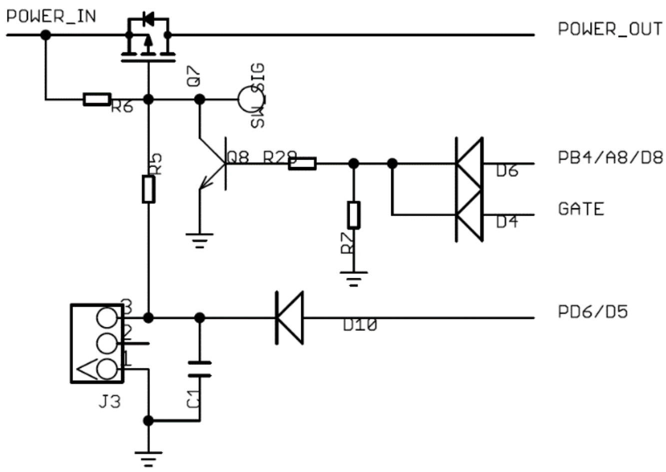
1） The system adopts 3.3V power supply, and the external power interface is Micro USB. When connected with external power source, it will convert to 3.3V through DC-DC, and supply power for the whole system. Meanwhile, 5V power source charge Lithium battery through CN3065 charge manager IC.



Switch Design

The system adopts single-switch circuit design. It adopts PMOS to switch. Power IN is for external power source input; and power out is controlled output. When the system is powered up, the transistor is in closed state. Pressing the button and MCU gets power supply and begins working. The output of MUC PB4/A8/D8 is high level; keeping MOS in a conducting state.

The system in normal working condition, press the button, and PD6/D5 is detested as low level; the system goes into low-consumption sleep mode. Meanwhile, the MOSFET is still in a conducting state. When the system detests that PD6/D5 is low level continuously, PB4/A8/D8 is high level, turn off the power supply of the system. (Valid only when the USB is not plugged in).

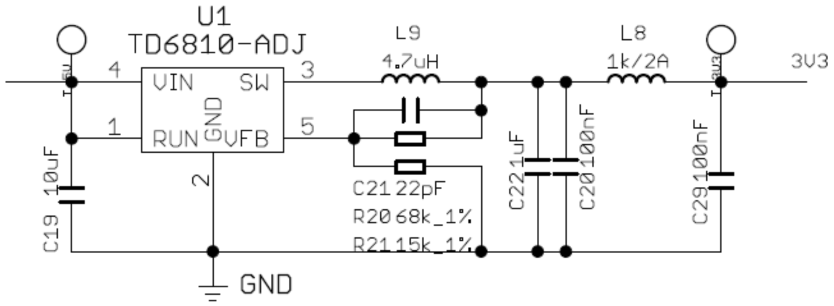


DC-DC Power Source Design

1) The system adopts 3.3V power source. To ensure the power utilization efficiency, DC-DC voltage-adjustable-circuit is adopted to convert 5V and 4.2V lithium battery to 3.3V. The conversion efficiency of this circuit can reach 85%.
2) It combines a MOSFET and a diode inside the Voltage-buck chip TD6810. Package is SOT23-5, and the maximum output current is 800mA. It needs external inductor filter and precision resistance for voltage feedback. It must be noted that feedback resistance shouldn't be set too large, usually not larger than 100K. Too large resistance will lead to too small current in the circuit, which is easily affected by electromagnetic interference; thus affects the output voltage stability.
3) Have to consider two elements (withstand current; inductance) when choosing the inductance. Under the circumstance that the current meets the demand of the circuit, increase the inductance to get more ideal power supply ripple.
4) The output terminal needs a filter capacitor. And change the capacitance according to the ripple size. L8 is a magnetic bead, which erases the High-frequency harmonics created by

DC-DC circuit, and ensures the system stability.

5) In this circuit, C21 is not soldered; when the input/output voltage is high, it needs to be set for filtering.



Photosensitive Sensors Design

1) Photosensitive circuit adopts photistor to test light intensity. The detection wavelength of the sensor is 400~1100nm, including visible light and Infrared band.
2) Photistor feedbacks analog signals, which need to be reshaped and filtered. Wave shaping circuit adopts a Schmitt trigger, using voltage difference between rising edge and falling edge to reduce the ripple.
3) The detection band of photistor includes infrared band. When many infrared-controlled devices are working frequently, it will affect the precision of Atom. At this time, software is needed to solve the problem by not collecting optical signals.

Buzzer Design

1) It adopts a 9mm diameter 3.3V buzzer, and does not need the system to drive it with oscillation frequency.
2) Adopts NPN transistor to drive the buzzer.

Indicator Design

1) It's equipped with 3 LEDs, whose functions are: power（VCC）and Reset（RESET）; battery condition（CN3065 control and PD7/A7/D6 control）; and user indicator（PC7/D13；PB7/D11）.
2) Battery condition and user LED adopt 2-color LED, providing 3 colors for LED (red, green and orange).
3) Power adopts transparent highlighted 2-color LED: blue for VCC and red for RESET.
4) Adopts NPN transistor to drive, saving for follow-up extended capability.

Charging Design

1) Adopts the existing CN3065 to design. The maximum charging current is 1A. It takes 20

minutes to fully charge the built-in 300mAh battery.

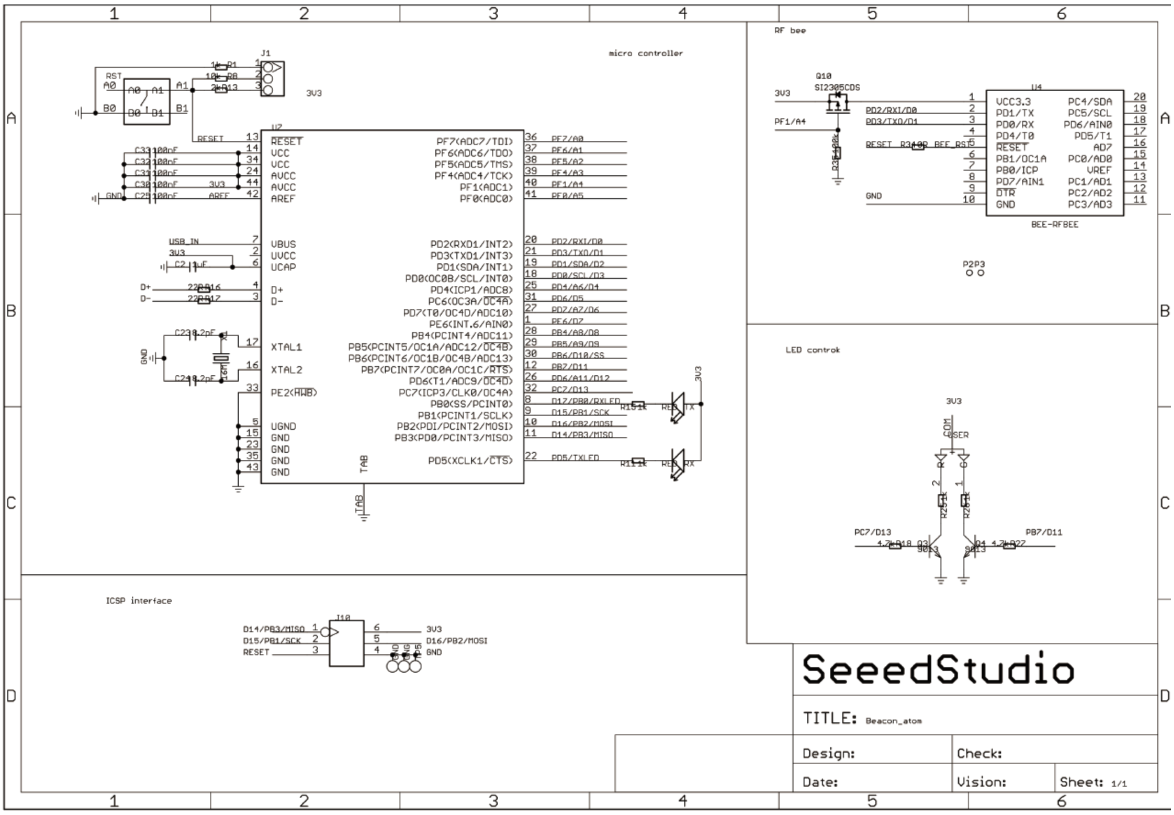
2) During charging process, the indicator is red; when finish charging, it turns to green.
3) The voltage of the battery is feedbacked to pin PF5/A2 through 2 10K resistors. When it's in low-battery level, the output of PD7/A7/D6 is high, and the charging LED shows red (use charging indicator repeatedly, using a diode to isolate power), indicating it needs charging. When it's not connected to external power source or when the battery is in normal state, the indicator won't light up.

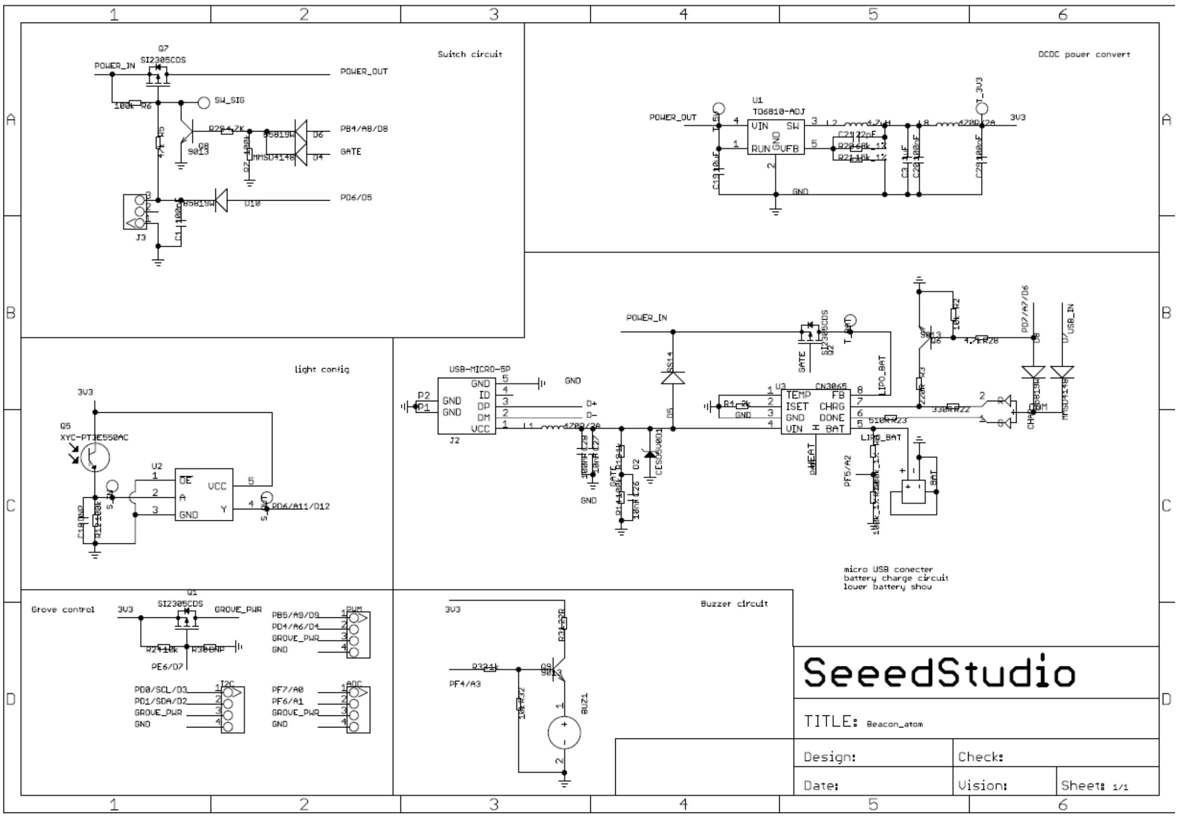
Low-Consumption Design

The purpose of this part is to turn off the power of Grove and Bee interface when MCU enters sleep mode.

1) The power of 3 Grove interfaces and Bee interface is controlled by P-MOSFET. When the system is in sleep state, the output of PE6/D7 and PF1/A4 is high, turning off the external power can save power. In normal state, PE6/D7 and PF1/A4 should be set as low-level and supply power for the device.
2) R30 is not soldered by default. When cancel R24 and set R30 as 10K, Grove interface power has output by default. When PE6/D7 outputs high level, turn off P-MOSFET.
3) In normal state, PE6/D7 and PF1/A4 have to be initialized.

Appendix：Schematics





Atom bug list

1．The photosensitive transmission speed is not fast enough (current, 1 byte/ms)
----adopts higher speed sensor.
2．Reset button is too big.
----adopts smaller packing.
3．Power indicator socket needs to be changed to smaller packing.
----adopts smaller packing socket.
4．Buzzer needs to be changed to smaller packing.
----adopts smaller packing interface.
5．Needs to hold the power source button while upgrading the program.
----Hardware update, keep it continuously conducted when USB supplies power.
6．Update low-consumption mode (software)
In hardware, add MOS to control RFBee power source independently.
7．Layout update.
8．