Application of applied Physics: Report

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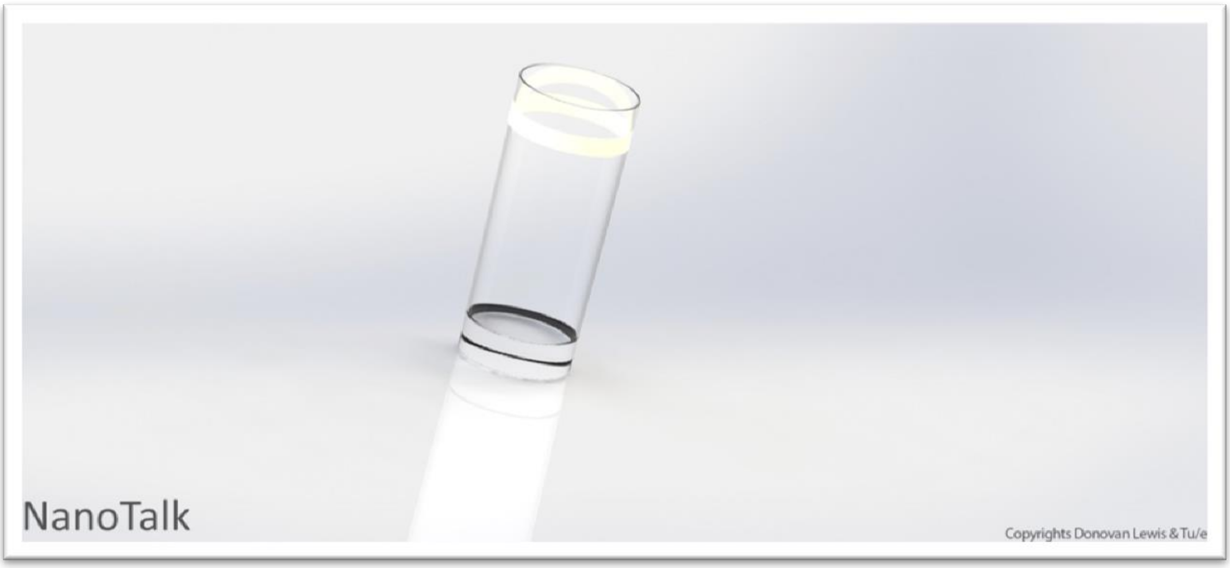


Introduction

This report is about an application of Applied Physics to a typical Industrial Design problem. This to show you that I'm able to apply physics on ill-defined design problems as on well-defined precooked exercises. I choose to link this report to my own next nature project, NanoTalk.

NanoTalk

NanoTalk is concept where a special bracelet, which you can wear and put around a glass shows your openness for a relationship during the nightlife.

The bracelet analyze with the built-in lab-on-a-chip's your saliva when you take a sip of your drink. After that this bracelet will start to get a certain color which is assigned to a specific amount of testosterone, which again is linked to certain status. For example: single = blue or just divorced = pink. This is possible because studies have pointed out that you can see changes in testosterone level based on you relationship status.

Problem

What is a proper power solution to power one NanoTalk bracelet for a whole evening?

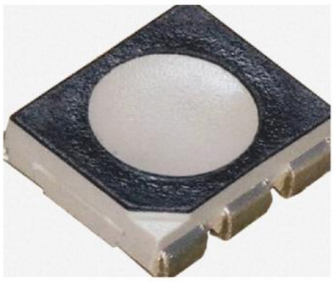
There are some factors which influence the power usage of the bracelet:

- The LED
- How much power the micro-controller uses
- How much power the Lab-on-a-chips uses
- How long it is turned on

These factors first need to be investigated before calculating the total power usage.

LED

I choose a RGB PLCC6 LED due to its size and Luminous Intensity. I studied the datasheet to gain some information about the LED.



CREE

Absolute Maximum Ratings (T_A = 25°C)

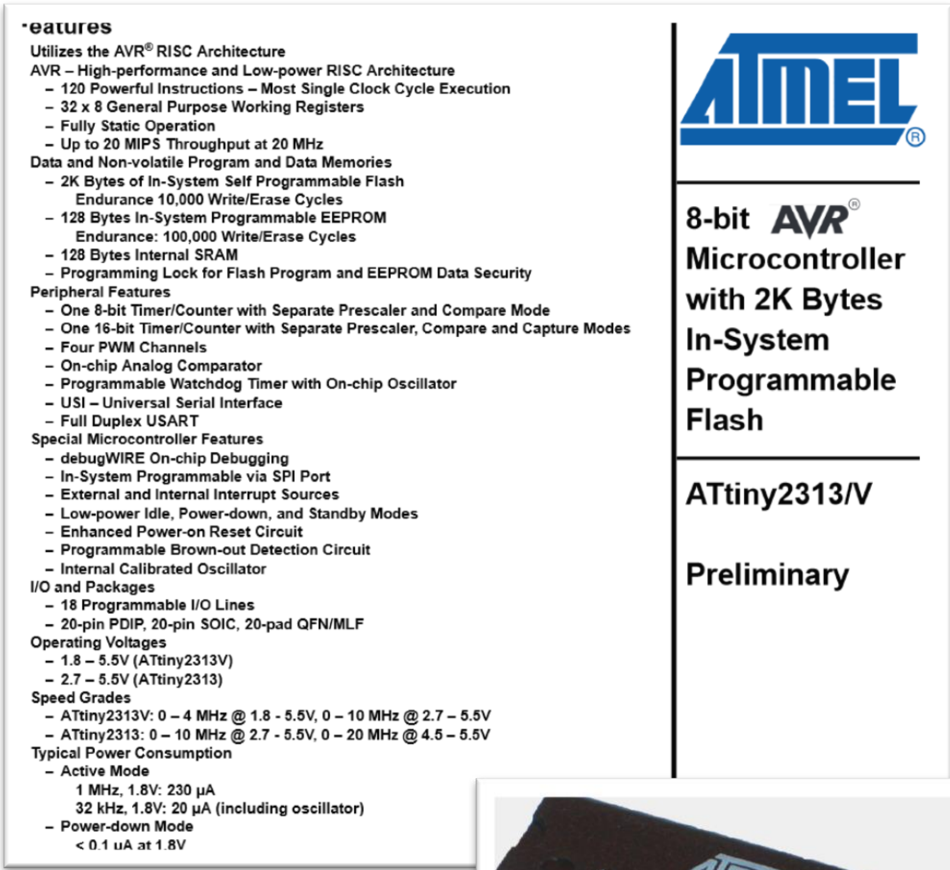
Items	Symbol	Absolute Maximum Rating			Unit
		R	G	B	
Forward Current [Note 1]	I_F	50	50	50	mA
Peak Forward Current [Note 2]	I_{FP}	200	100	100	mA
Reverse Voltage	V_R	5	5	5	V
Power Dissipation	P_D	125	200	200	mW
Operation Temperature	T_{opr}	-40 ~ +100			°C
Storage Temperature	T_{stg}	-40 ~ +100			°C
Junction Temperature	T_J	110	110	110	°C
Junction/ambient 1 chip on	R_{THJA}	450	400	450	°C/W
Junction/ambient 3 chips on	R_{THJA}	650	580	680	°C/W
Junction/solder point 1 chip on	R_{THJS}	300	280	300	°C/W
Junction/solder point 3 chips on	R_{THJS}	450	430	480	°C/W
Electrostatic Discharge Classification (MIL-STD-883E)	ESD	1000 V			

Note:
1. Single-color light.
2. Pulse width ≤0.1 msec, duty ≤1/10.

We need at least a 5V 50mA battery if we assume that when the LED is making certain colors in total only one LED is on.

Microcontroller

I've compared different microcontrollers to energy consumption, dimensions and possibilities. That resulted that the ATtiny2313/V[1] is most suitable for the bracelet. That because he can already operate at 1.8 volts and 230µA and is very small.



·eatures

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Peripheral Features
- One 8-bit Timer/Counter with Separate Prescaler and Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare and Capture Modes
- Four PWM Channels
- On-chip Analog Comparator
- Programmable Watchdog Timer with On-chip Oscillator
- USI – Universal Serial Interface
- Full Duplex USART

Special Microcontroller Features
- debugWIRE On-chip Debugging
- In-System Programmable via SPI Port
- External and Internal Interrupt Sources
- Low-power Idle, Power-down, and Standby Modes
- Enhanced Power-on Reset Circuit
- Programmable Brown-out Detection Circuit
- Internal Calibrated Oscillator

I/O and Packages
- 18 Programmable I/O Lines
- 20-pin PDIP, 20-pin SOIC, 20-pad QFN/MLF

Operating Voltages
- 1.8 – 5.5V (ATtiny2313V)
- 2.7 – 5.5V (ATtiny2313)

Speed Grades
- ATtiny2313V: 0 – 4 MHz @ 1.8 - 5.5V, 0 – 10 MHz @ 2.7 – 5.5V
- ATtiny2313: 0 – 10 MHz @ 2.7 - 5.5V, 0 – 20 MHz @ 4.5 – 5.5V

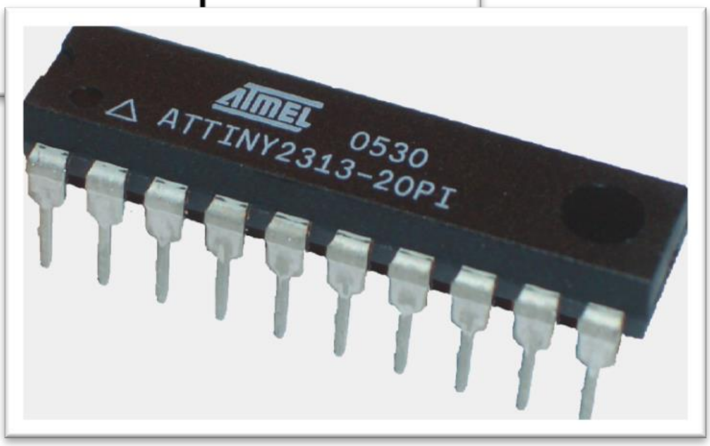
Typical Power Consumption
- Active Mode
  1 MHz, 1.8V: 230 µA
  32 kHz, 1.8V: 20 µA (including oscillator)
- Power-down Mode
  < 0.1 µA at 1.8V

ATMEL®

8-bit AVR® Microcontroller with 2K Bytes In-System Programmable Flash

ATtiny2313/V

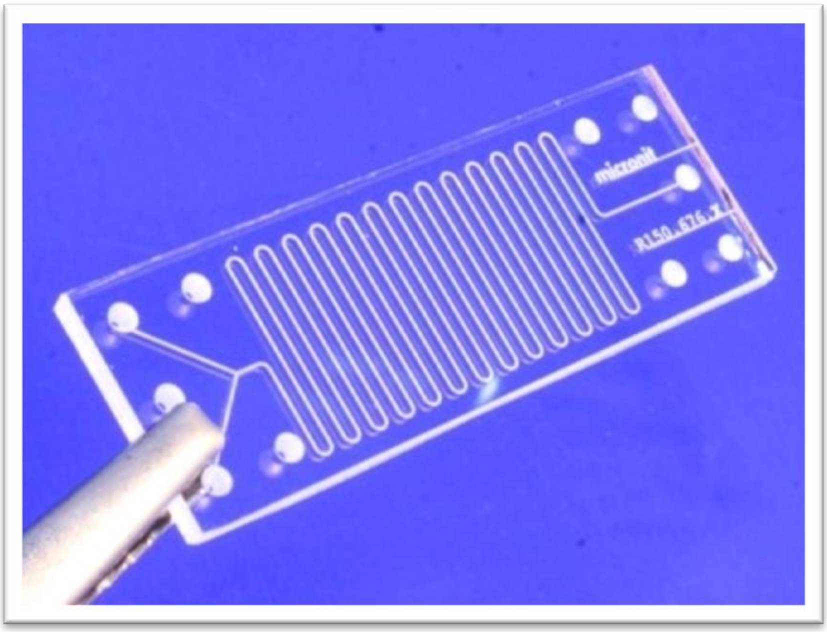
Preliminary



[1] http://www.atmel.com/images/doc2543.pdf (accessed 30-1-2014)

Lab-on-a-chip (LOC)

It's not completely clear how much power a LOC needs to operate. Most of the power is used to pump the solution through the micro-channels. New research[2] has ensured that the first required 10KV is brought down to an astounding 0.25V. I further need to assume that current isn't very high either. So I assume that it is bit more than a micro-controller, so around 500µA.



A night out

I looked to typical opening hours from different bars and club. By comparing the different opening hours I came to average of 6 hours a night.

[2] Peter Iglinski-Rochester. University of Rochester. 2013. http://www.futurity.org/membrane-shrink-power-lab-on-a-chip/ (Accessed 28-1-2014)

Total power consumption

Current

By answering all the sub-question I can now answer my main question. If I add up each factor, I come to a total of;

$$50mA + 230\mu A + 500\mu A = 50.73mA$$

I need that amount of ampere for at least 6 hours. So the battery will at least need to be;

$$50.73mA * 6\ Hours = 304.38mA$$

Voltage

The total voltage what needs to be provided is;

$$5V + 0.25V + 1.8V = 7.05V$$

So a proper power solution is:

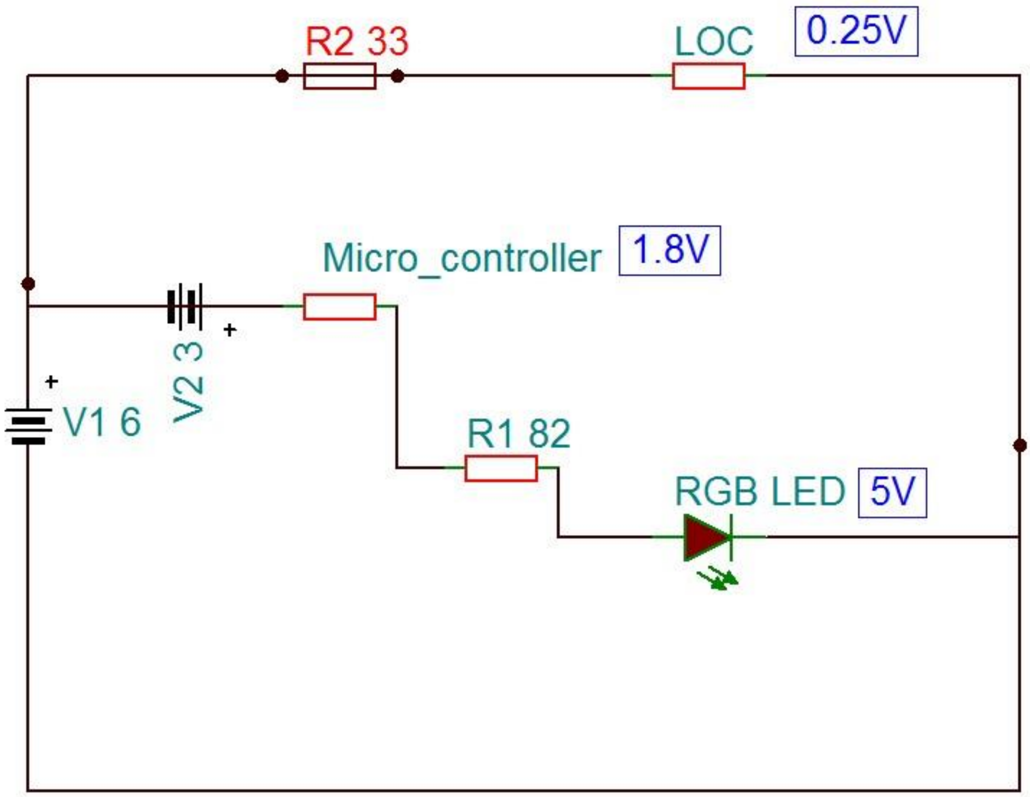
Lithium Coin BR1220

Brand Range	Panasonic BR
Capacity	35mAh
Chemistry	Lithium Polycarbon Monofluoride
Diameter	12.5mm
Dimensions	12.5 x 2mm
Maximum Continuous Current	0.03mA
Maximum Operating Temperature	+80°C
Minimum Operating Temperature	-30°C
Nominal Voltage	3V
Operating Temperature Range	-30 → +80°C
Size	BR1220
Terminal Type	Standard
Typical Application	Calculators, Cameras, Watches

Varta 6.0V, CP300H NiMH Rechargeable Coin Cell Battery, Tagged Terminal, 300mAh

Capacity	300mAh
Chemistry	NiMH
Diameter	25.1mm
Dimensions	7.55 x 25.1mm
Maximum Continuous Current	560mA
Mounting Orientation	Vertical
Nominal Voltage	6.0V
Operating Temperature Range	-20 → 65°C
Size	CP300H
Terminal Type	Tagged

Electronic circuit



- V1 = Varta 6.0V, CP300H NiMH Rechargeable Coin Cell Battery, Tagged Terminal, 300mAh
- V2 = Lithium Coin BR1220
- R1 = 9/50*10^-3 ≈ 82Ω
- R2 = 6/185*10^-3 ≈ 33Ω

The idea is that the rechargeable batteries will be recharged every evening where the coin batteries will be replaced once every month.

Capacity coin battery/Usage microcontroller= Operating ours
35mAh/230µ = 152.17 Hours
152.17/6(hours each evening)= 25.3 Evenings will it last