# Water Level Sensor Design Notes

## Voltage regulator efficiency experiments

Pololu 3.3V 500mA step down regulator

* No load

|  |  |
| --- | --- |
| Input voltage | Input current |
| 5V | 117uA |
| 6.5V | 107uA |

* With 27.5uA load (120K resistor)

|  |  |
| --- | --- |
| Input voltage | Input current |
| 5V | 134uA |
| 6.5V | 123uA |

* with 10.0mA load (330ohm resistor)

|  |  |
| --- | --- |
| Input voltage | Input current |
| 5V | 7.6mA |
| 6.5V | 5.7mA |

Pololu 5V step up/down regulator

* no load

|  |  |
| --- | --- |
| Input voltage | Input current |
| 5V | 61.5uA |
| 6.7V | 58.6uA |

* with 2.7mA load (MB7389 ultrasonic sensor)

|  |  |
| --- | --- |
| Input voltage | Input current |
| 5V | 3mA |
| 6.7V | 2.55mA |

* with 15.7mA load (330ohm resistor)

|  |  |
| --- | --- |
| Input voltage | Input current |
| 5V | 20mA |
| 6.5V | 15.4mA |

Pololu 3.3V step up/down regulator

* AtMega328P in sleep mode

|  |  |
| --- | --- |
| Input voltage | Input current |
| 4.3V | 49.6uA |
| 5.8V | 54.2uA? |
| 7.3V | 46.8uA |

## Voltage regulation dynamic tests

Using the Pololu SLOscope the power used during SIM800 operations has been measured. Measurements were taken on the breadboard prototype.

With a 4.4V alkaline battery pack the output of the 4.1V regulator (S7V8A) to the SIM800 varies between 3.79V and 4.11V (about a 0.32V drop) with two 330uF low ESR capacitors on the input to the regulator. With only one capacitor the range is 3.66 to 4.17 (about a 0.51V drop). A manual cellular session took 0.62mAh, an automated session took 0.4mAh

5.88V alkaline battery pack. A manual cellular session took 0.41mAh. 3.8mA peripheral power off, 8.2mA peripheral power on.

7.3V 3.3mA pp off, 7.1mA pp on, manual session 0.32mAh, automated session 0.24mAh

## Hardware Design

There will be an attempt to design a general-purpose cellular data system. Load program through RJ45 jack? No. Debug console via sw serial with RJ11 jack (only need 4 pins)?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | I2C | SPI | HW UART | 3.3V | 4.1V | 5V |
| Water level sensor | TMP102 |  | MB7389 | uC | SIM800 | MB7389 |
| Water pressure sensor | TMP102 | SSP… |  | uC |  | SSP… |
| LED lighting ups remote monitor | TMP102? |  |  | uC | SIM800 | Comes from UPS |
| Remote GPS tracker | TMP102? |  | SkyTraq | uC | SIM800 | no |

### Power source

A 4.5V battery pack of 12 Alkaline D cells will supply at least 48Ah. However, the voltage range through the life of the batteries is not sufficient (See Experiment below). Instead a 7.5V battery pack will be used (3 strings of 5 D-cells in parallel). This should supply at least 40Ah.

Hydrogen gas generation in water proof battery compartments needs to be addressed as a potential safety issue to prevent the accumulation of dangerous levels of hydrogen gas within the device.

### Power Management

Power-down mode current looks like it’s less than 10uA. (7uA measured on 4/21/2017)

### Experiment: Running on 3V

An experiment powering the prototype with two AA batteries to emulate the conditions of the 4.5V battery pack when it is nearly completely drained. Alkaline batteries drain down to 0.8V.

With 3V the prototype failed to initiate an IP connection over cellular. The scope showed voltage dips that fell below minimum voltages. We may need a stronger up/down regulator for the cellular module. Currently using S7V8A (1A). May need a bigger regulator or bigger capacitors. Voltage too low to maintain serial communication with Pololu USB-to-serial module. A level shifter was needed to get the UART voltages back to an acceptable level.

As a result of this experiment the conclusion reached is that a 4.5V battery pack will not be sufficient. The voltage range at the end of the batteries’ useful life rules this out.

### AtMega328P

* run directly off 4.5V battery pack – no regulator needed. This means the power-down current will be only that which the AtMega328P uses (about 7uAh)
* run with 8MHz crystal
* 8-bit Timer0 – Software serial rx for debug console (4800 baud)
* 16-bit Timer1 - system clock and sotware serial tx for SIM800 and debug console (4800 baud)
* 8-bit Timer2 – software serial rx for SIM800
* Hardware UART Rx for ultrasonic sensor (9600 baud)
* Use power-down mode for sleep

### I/O Pin usage

PD0 – hardware UART Rx for ultrasonic sensor

PD2,PD3 – Software serial Rx/Tx for SIM800 (4800 baud)

PD4 – onkey for SIM800

PD5 – power status (not using)

PC4,PC5 - I2C for optional MCP9808 temperature sensor

PB0,PB1 – Software serial Rx/Tx for debug console (4800 baud)

PB2 – SS for SPI

PB3-PB5 SPI for pressure sensor

## Time sync with server

(Tasleep \* 1000) / (Tasleep + Tadj) is the scale factor (at a particular temperature) for WDT sleep time.

When computing next sample time we need to account for the possibility that the WDT was running fast and we posted early. We want to avoid posting again right away. To address this we add ½ the sample interval to the current time before aligning. Aligning is therefore:

nextSampleT = (floor((t + (sampleInterval / 2)) / sampleInterval) + 1) \* sampleInterval

Similarly, the decision to report at the current sample time is given by:

((t + (sampleInterval / 2)) % reportInterval) < sampleInterval

## Control flow

Water Level monitor task returns status that reports when it is done processing (reading sensors, posting data to server). When it is done we enter a sleep loop until the next scheduled processing time.

Initialize

Loop {

Tasks

If monitor task is done {

Finalize

Sleep until next interval

Initialize

}

}

Be sure to have timeout for registering on cell network.

Be sure to set BODLEVEL to 1.8V

## SparkFun SSOP to DIP Adapter - 8-Pin

BOB-00497

Eagle SOT-223 pkg: linear-technology-2:LT1129CST5

Use 1N4148 diode to level-shift 3V3 Rx pin of microcontroller to USB-to-serial adapter (assumes pull-up on Rx pin).