**System Design and Modeling**

**T05 – Handheld Electronic Compass**

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Handheld Compass

Battery (+3.7V)

USB (+5V)

USB (data)

LCD Display

Battery (chrg.)

**Level 0**

USB (data)

Earth’s Magnetic Field

|  |  |
| --- | --- |
| *Module* | Handheld Electronic Compass |
| *Inputs* | Battery: +3.6V DC  Earth’s Magnetic Field: ±3.1 to ±8.1 gauss full-scale USB +5V: +5V DC supplied from the USB port USB Data: Serial communication for programming the microcontroller |
| *Outputs* | LCD Display: show heading on compass face and degrees from North Battery Charge: 100 mA constant current charge for Lithium-ion Polymer battery  USB Data: acknowledgement of successful programming of the microcontroller; can be used for other purposes in the future |
| *Functionality* | The Handheld Electronic Compass will display a compass face with directional arrow and the degrees from North, from 0 to 360 degrees. LCD is updated every 5 ms running the microcontroller at 1 MHz. |

Magnetometer

μC

LCD

PMIC

Batt

USB (data)

USB (+5V)

+3.3V

I2C

SPI

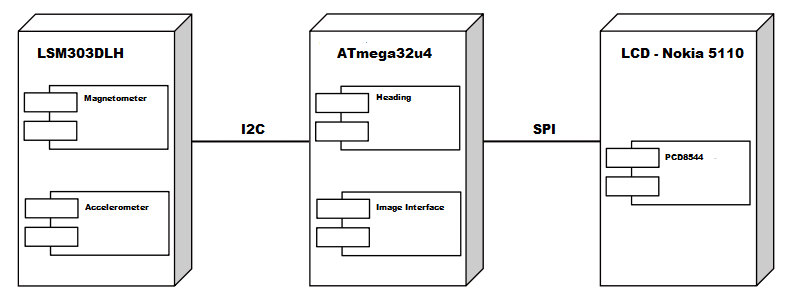
Batt. (chrg)

Compass Display

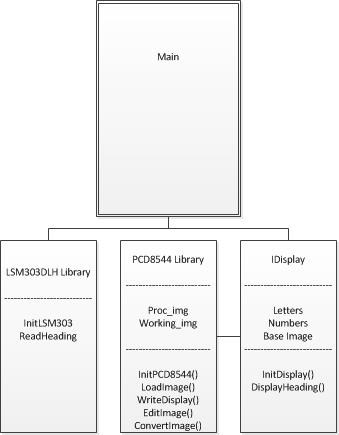
+3.3V

**Level 1**

Earth’s Magnetic Field



Physical View of the system.



Class diagram of system.

μC

ATmega32u4

+3.3V

USB +5V

USB Data

I2C

I2C

SPI

**Level 0**

USB Data

|  |  |
| --- | --- |
| *Module* | Microcontroller: ATmega32u4 |
| *Inputs* | +3.3V: From PMIC, main power source USB +5V: +5V DC supplied from the USB port USB Data: Serial communication for programming the microcontroller  I2C: Contains requested data from magnetometer/accelerometer reading, transmitted serially encoding the degree heading in 16 bits; 2’s complement x, y, and z parameters from the accelerometer and heading value from magnetometer |
| *Outputs* | I2C: Commands and requests for data, transmitted serially  SPI: Microcontroller outputs a bitmap to the LCD relative to the heading, transmitted serially using 8 bits USB Data: acknowledgement of successful programming of the microcontroller; can be used for other purposes in the future |
| *Functionality* | The microcontroller is the brains of the device. It establishes communication with the magnetometer and the LCD display. The μC interprets data from the magnetometer then sends the appropriate bitmap to the LCD for display. It receives power from both the PMIC and/or the USB port. |

+3.3V

I2C

**Magnetometer/ Accelerometer**

LSM303DLH

I2C

**Level 0**

Earth’s Magnetic Field

|  |  |
| --- | --- |
| *Module* | Magnetometer: LSM303DLH |
| *Inputs* | +3.3V: From PMIC with switch controlled by μC GPIO, main power source  Earth’s Magnetic Field: ±3.1 to ±8.1 gauss full-scale  I2C: Commands and requests for data, transmitted serially |
| *Outputs* | I2C: Contains requested data from magnetometer/accelerometer reading, transmitted serially encoding the degree heading in 16 bits; 2’s complement x,y,z parameters from the accelerometer and heading value from magnetometer |
| *Functionality* | The magnetometer senses the Earth’s magnetic field, and, with the aid of a built-in accelerometer, sends data to the microcontroller related to the user’s orientation and movements. Calibration on startup from microcontroller (reference to North). |

+3.3V

SPI

Heading Display

**LCD**

Nokia 5110

**Level 0**

|  |  |
| --- | --- |
| *Module* | LCD Display: Nokia 5110 |
| *Inputs* | +3.3V: From PMIC with switch controlled by μC GPIO, main power source SPI: Microcontroller outputs a bitmap to the LCD relative to the heading, transmitted serially using 8 bits |
| *Outputs* | Heading Display: compass face and heading in degrees between 0 and 360 |
| *Functionality* | The LCD Display outputs an image of a compass face as well as the heading in degrees from North between 0 and 360 degrees. The image comes from a library of pre-defined bitmap images stored in the μC memory. |

USB +5V

Batt. +3.7V

+3.3V

Batt. Chrg.

**PMIC**

LTC4067

**Level 0**

|  |  |
| --- | --- |
| *Module* | PMIC: LTC4067 |
| *Inputs* | USB +5V: supply from USB port, used to charge battery when connected Battery +3.7V: A lithium-ion polymer, 400 mAh, 2C battery |
| *Outputs* | +3.3V: Regulated voltage output Batt. Chrg: 100 mA regulated current to charge the LiPo battery |
| *Functionality* | The PMIC manages the power distribution by regulating the output voltage supplied to the system and charges the battery when the system is connected via USB. |