SenseWalk 2.0

Group 23

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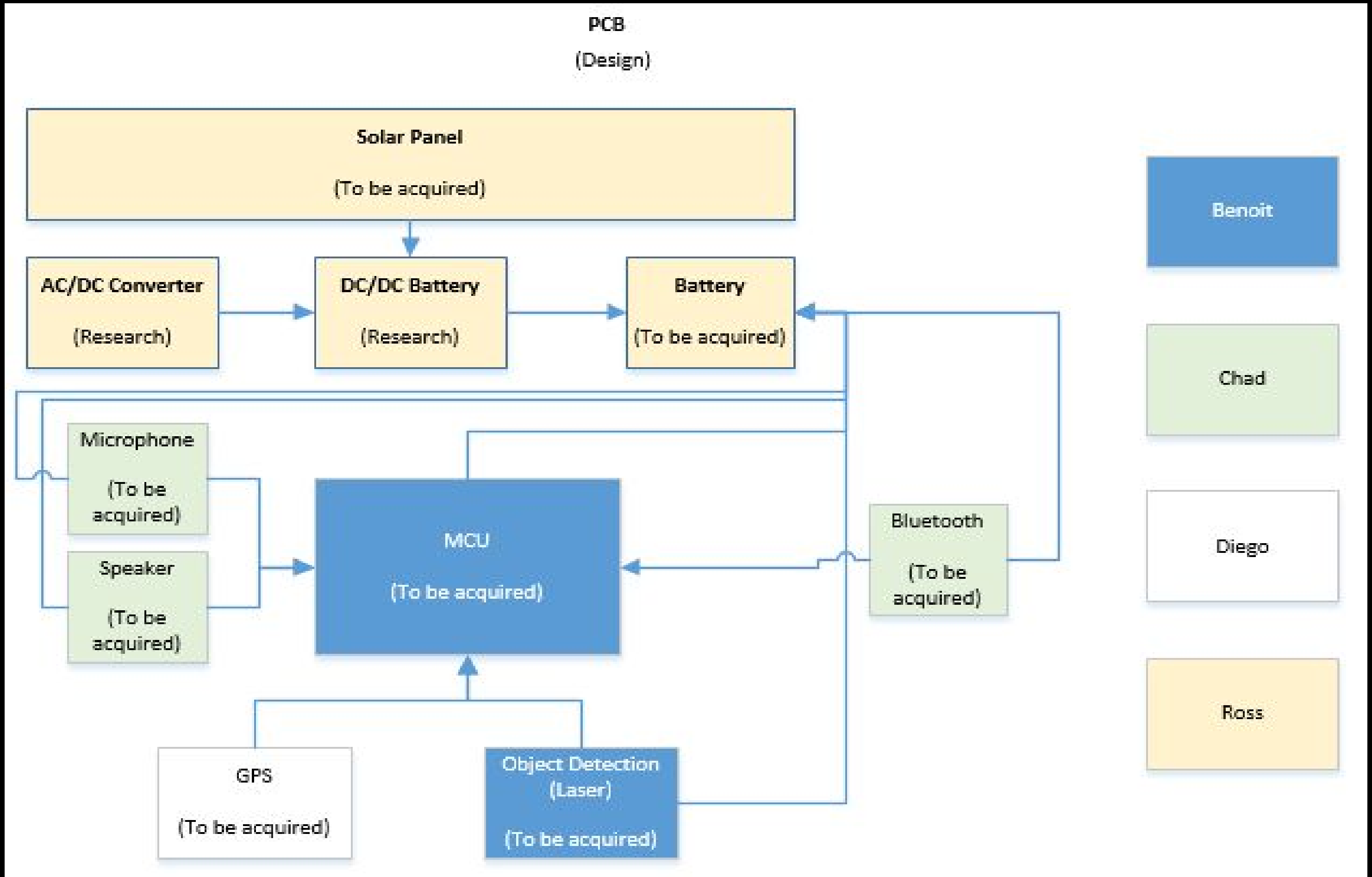
Project Goals and Objectives

- Create a device which helps the visually impaired navigate life
  - Warn user of obstacles ahead of time
  - Provide navigation assistance
  - Audio input/output
- This project was inspired by Sensewalk. Improvements include:
  - Faster response time
  - Lighter weight
  - Improved battery life
  - Greater precision

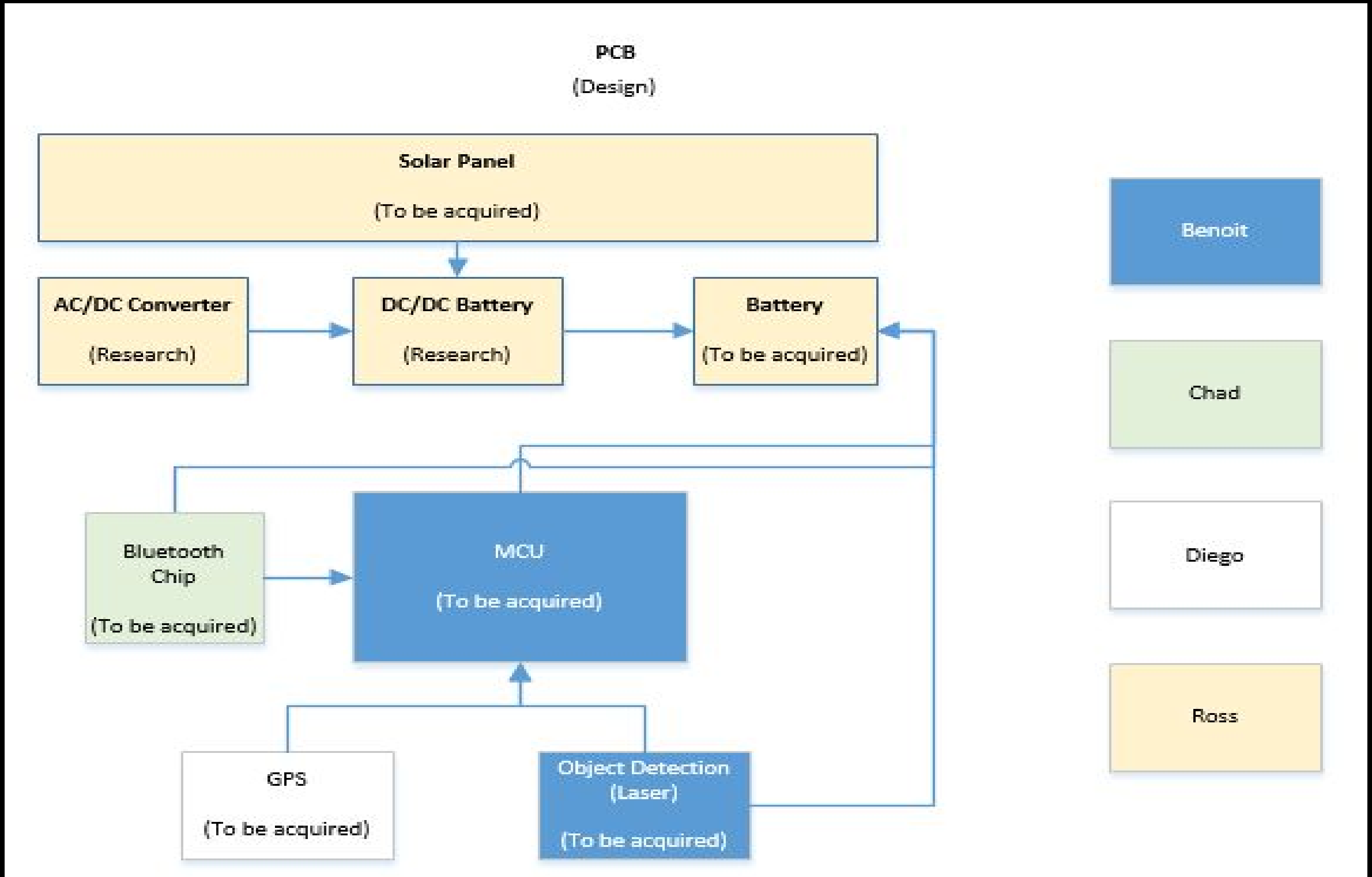
Design Constraints

- Economic and Time Constraints
  - Printed circuit board manufacture takes three weeks
    - Any design mistake results in failure
  - Hand assembly of extremely small (0.5mm pitch)components by inexperienced students
    - Any excessive shaking results in failure
  - Professional assembly is costly (used for some components of SenseWalk 2)
- Firmware update may result in a bricked device
- Everything was learned on the spot

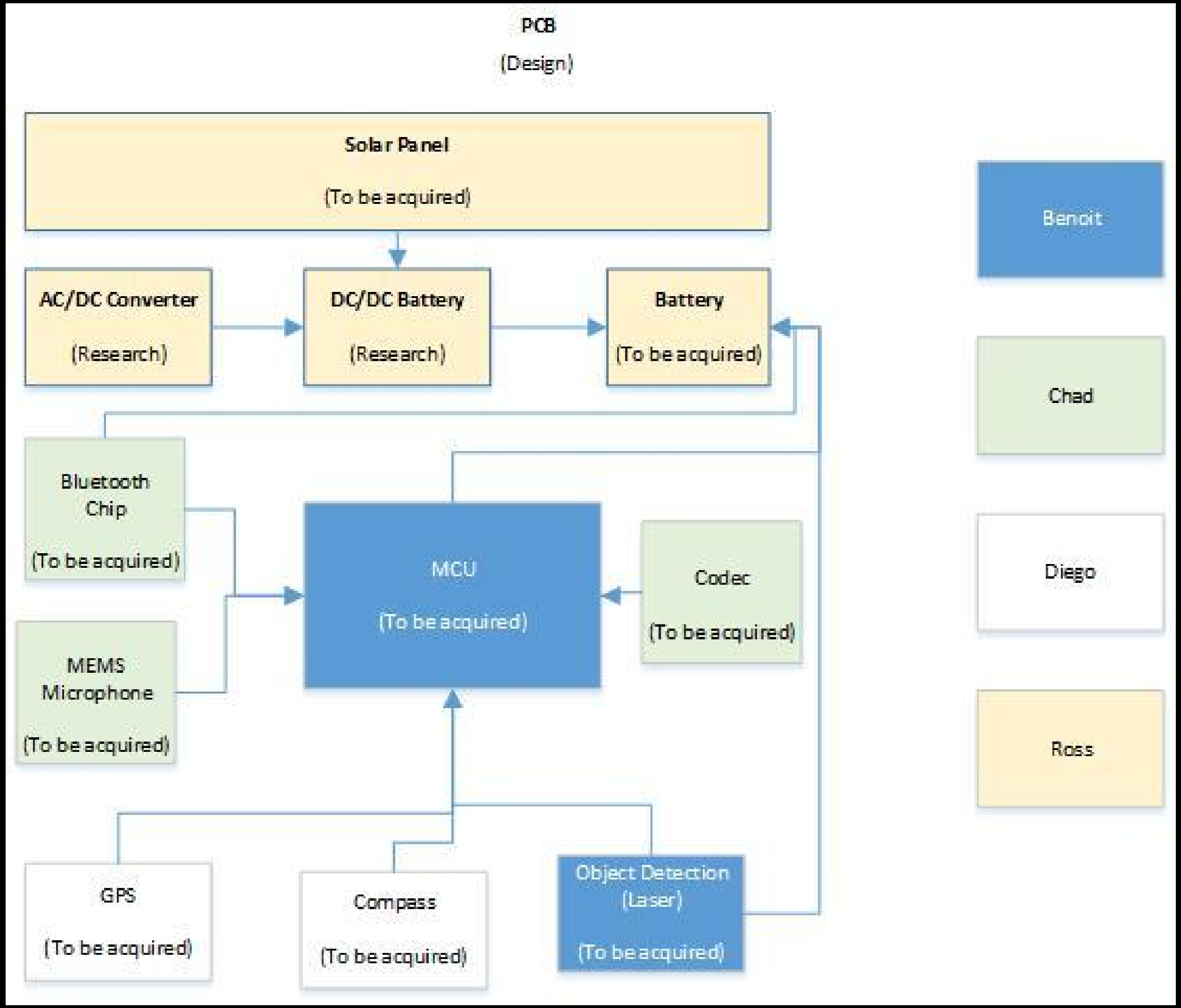
Block Diagram – 1st Design



Block Diagram – 2nd Design



Block Diagram – Current Design



Bluetooth

Name	Bluetooth Classic	Bluetooth 4.0 Low Energy (BLE)	WiFi
IEEE Standard	802.15.1	802.15.1	802.11 (a, b, g, n)
Frequency (GHz)	2.4	2.4	2.4 and 5
Maximum raw bit rate (Mbps)	1-3	1	11 (b), 54 (g), 600 (n)
Typical data throughput (Mbps)	0.7-2.1	0.27	7 (b), 25(g), 150 (n)
Maximum (Outdoor) Range (Meters)	10 (class 2), 100 (class 1)	50	100-250
Relative Power Consumption	Medium	Very low	High
Example Battery Life	Days	Months to years	Hours
Network Size	7	Undefined	255

Audio Output

- Audio Codec:
  - Easy design
  - Handles MPEG Audio Files

STA013 MPEG 2.5 LAYER III AUDIO DECODER

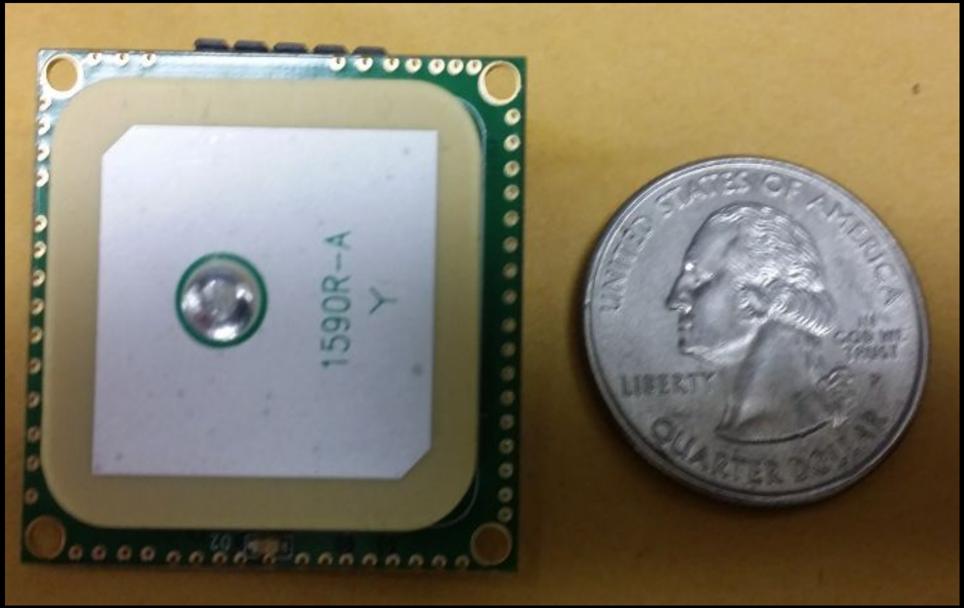
- Bluetooth to Headphone
  - User has freedom to choose a headphone or speaker device that best fits them.

Microchip RN52

GPS

FEATURES	
Update Rate	5Hz -10 Hz
Channels	66 (22 tracking)
Power Consumption	3.3 V @ 41 mA
LED Indicator	Fix or no Fix
Acquisition Time	Hot Start 1s,Cold Start 32 s
Max altitude	5000 m
Embedded Antenna	
Built-in micro battery	Preserve the system data for rapid satellite acquisition
Velocity	515 m/s
Price	$59.99

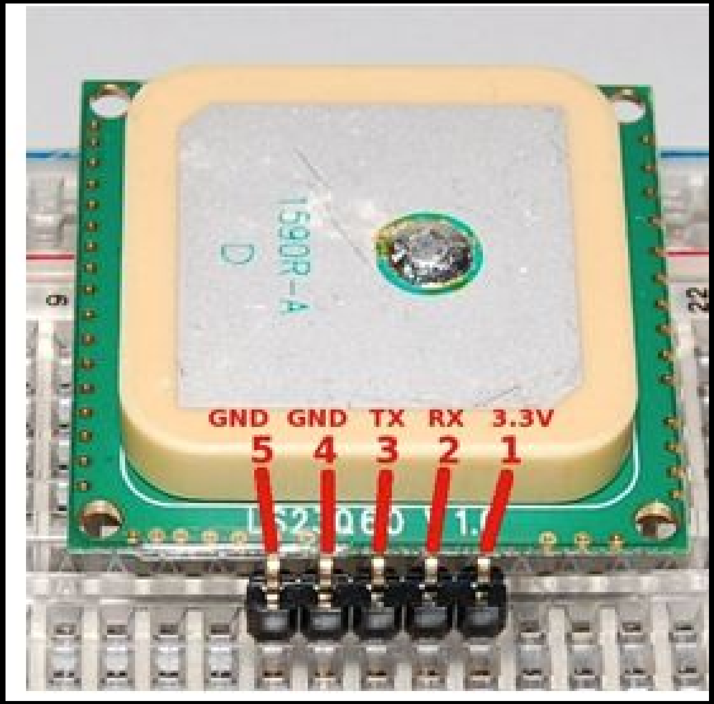
Locosys LS20031



GPS

PIN ASSIGNMENT

PIN#	NAME	DESCRIPTION
1	VCC	Power Input
2	RX	Data Input
3	TX	Data Output
4	GND	Ground
5	GND	Ground



GPS

$GPGGA,053740.000,2503.6319,N,12136.0099,E,

$GPGLL,2503.6319,N,12136.0099,E,053740.000,A,A*52

Table 5.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	2503.6319		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W indicator	E		E=east or W=west
UTC Time	053740.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator

GPS DATA RECEIVED

Data no Valid

```
$GPGGA,000147.599,,,,,0,0,,M,,M,,*4F
$GPGLL,,,,,000147.599,V,N*7D
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GPGSV,1,1,00*79
$GPRMC,000147.599,V,,,,,0.00,0.00,060180,,,N*45
$GPVTG,0.00,T,,M,0.00,N,0.00,K,N*32
$GPGGA,000147.799,,,,,0,0,,M,,M,,*4D
$GPGLL,,,,,000147.799,V,N*7F
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GPGSV,1,1,00*79
$GPRMC,000147.799,V,,,,,0.00,0.00,060180,,,N*47
$GPVTG,0.00,T,,M,0.00,N,0.00,K,N*32
$GPGGA,000148.000,,,,,0,0,,M,,M,,*45
$GPGLL,,,,,000148.000,V,N*77
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GPGSV,1,1,00*79
$GPRMC,000148.000,V,,,,,0.00,0.00,060180,,,N*4F
$GPVTG,0.00,T,,M,0.00,N,0.00,K,N*32
$GPGGA,000148.200,,,,,0,0,,M,,M,,*47
$GPGLL,,,,,000148.200,V,N*75
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GPGSV,1,1,00*79
$GPRMC,000148.200,V,,,,,0.00,0.00,060180,,,N*4D
$GPVTG,0.00,T,,M,0.00,N,0.00,K,N*32
$GPGGA,000148.400,,,,,0,0,,M,,M,,*41
$GPGLL,,,,,000148.400,V,N*73
```

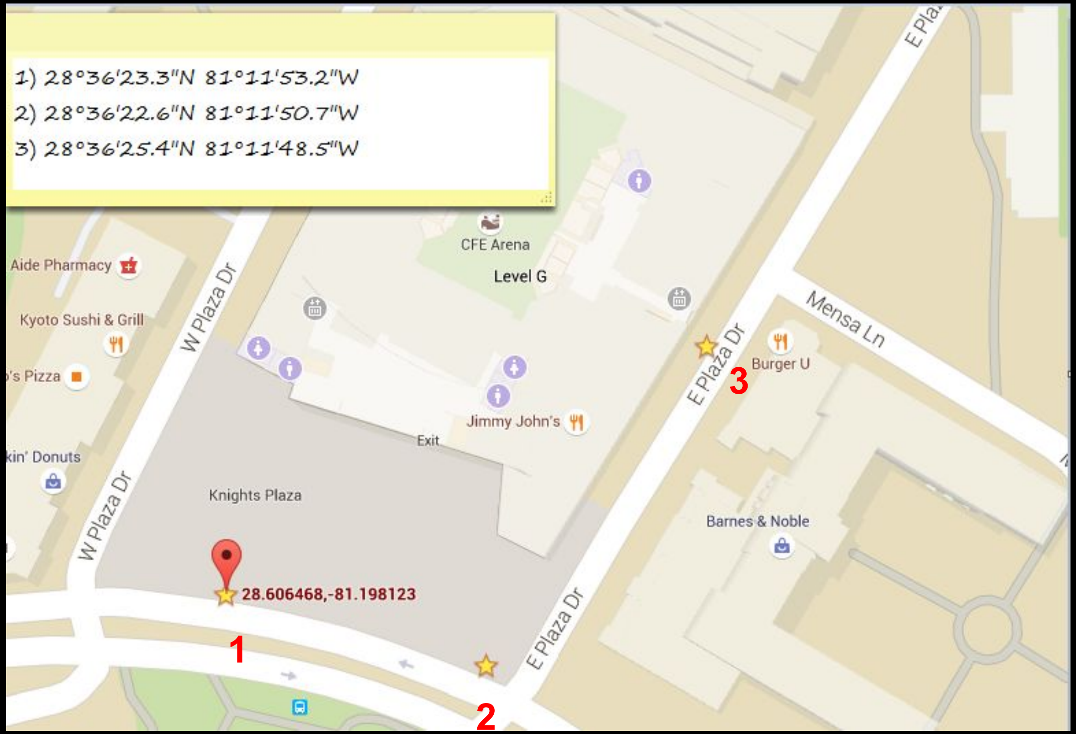
GPS

-Routes will pre-set as shown in the figure

-Routes will be given a specific name, for example “route one”. “School”, “restaurant one”

-User will be able to request which route to go through verbal commands since device will be able to receive and output audio since a microphone and a headset will be incorporated.

-Once the request is processed, the gps will read the user position and a voice command will tell the user how to get to the next coordinate
For example: go left , once user gets to the specific coordinate, a new voice command will be given to the user, “go right” and so on until the user gets to the final destination.



Magnetometer

A magnetometer is used to provide the user with a compass functionality, and to assist the GPS in directing the user.

We chose the Melexis **MLX90393** Triaxis Magnetometer, which measures the magnetic field magnetic field in the X, Y, and Z direction using the Hall Effect. It returns three μT (micro Tesla) values.

Hardware: The MLX90393 comes in a 16-pads QFN package. (0.5mm pitch)

Interface: SPI with precise timing requirements

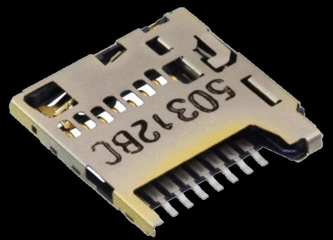
Software: Remember each axis' min and max value for calibration

Fun fact: The MLX90393 is made in Belgium

CPU vs MCU

CPU > MCU

# of components

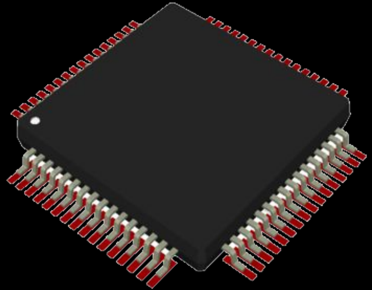


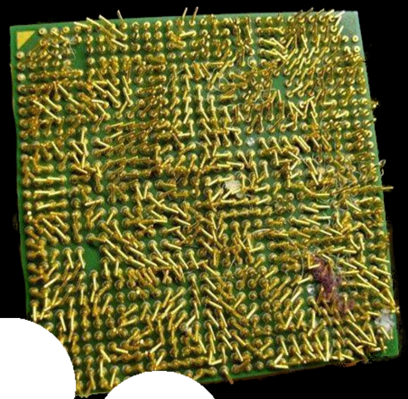
Software libraries

OpenCV

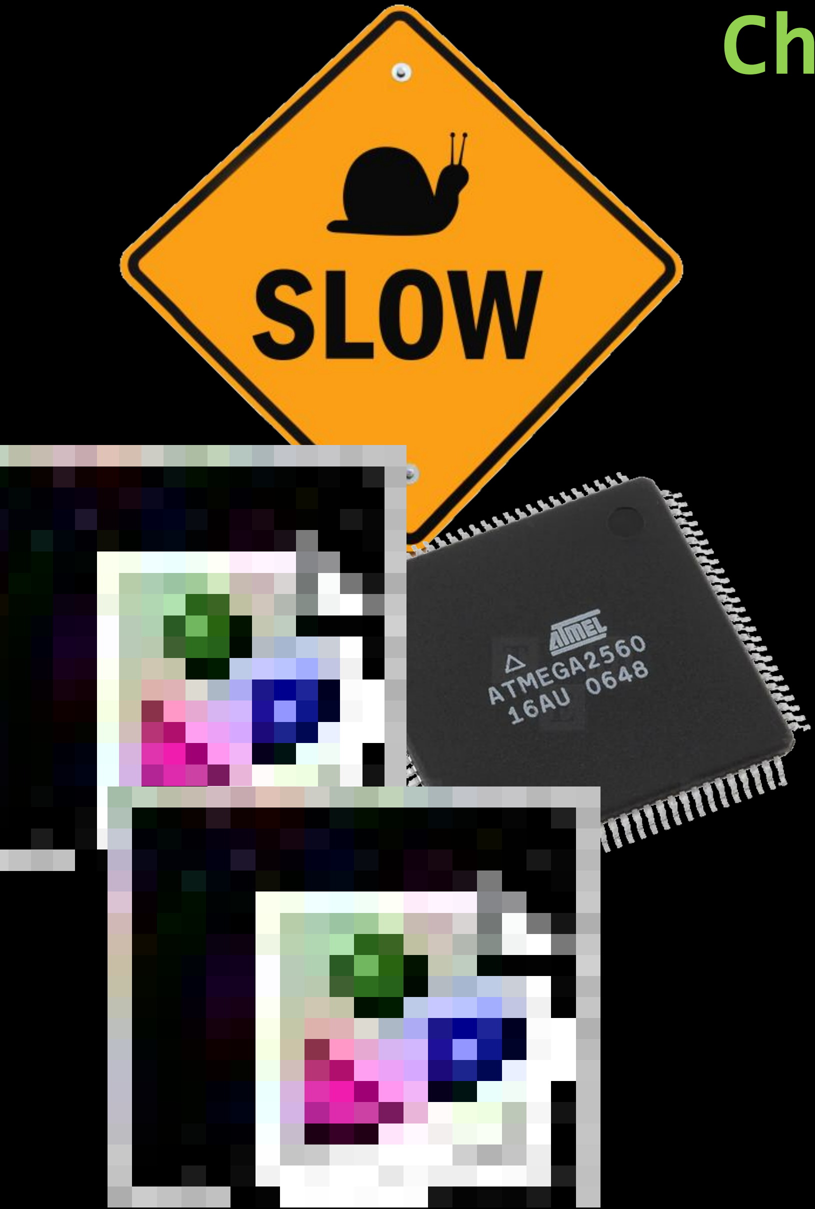
Julius

MCU > CPU
Pin count, power usage





Choice of MCU



TI MSP43X, ATmel ATMega
16 MHz - 40 MHz (too slow)

ARM Cortex-M7
Up to 300 MHz

Freescale Kinetis:
$160 development board
$200 programmer/debugger

STMicroelectronics STM32 F7:
$50 development board
$20 programmer/debugger

life.augmented

Microcontroller
and
Development Platform

ARM mbed

STM32F7
STM32L4

STM32F7-Disco board: $49
ARM Cortex-M7, SD port

STM32L4-Nucleo board: $10.99
ARM Cortex-M4, ultra-low power

ST-Link/V2 programmer/debugger: $20.82
Serial-wire (2-wires), OpenOCD ($3.21 on eBay)

STM32F746

LQFP100,144,...	216MHz	320KB RAM	1MB Flash	

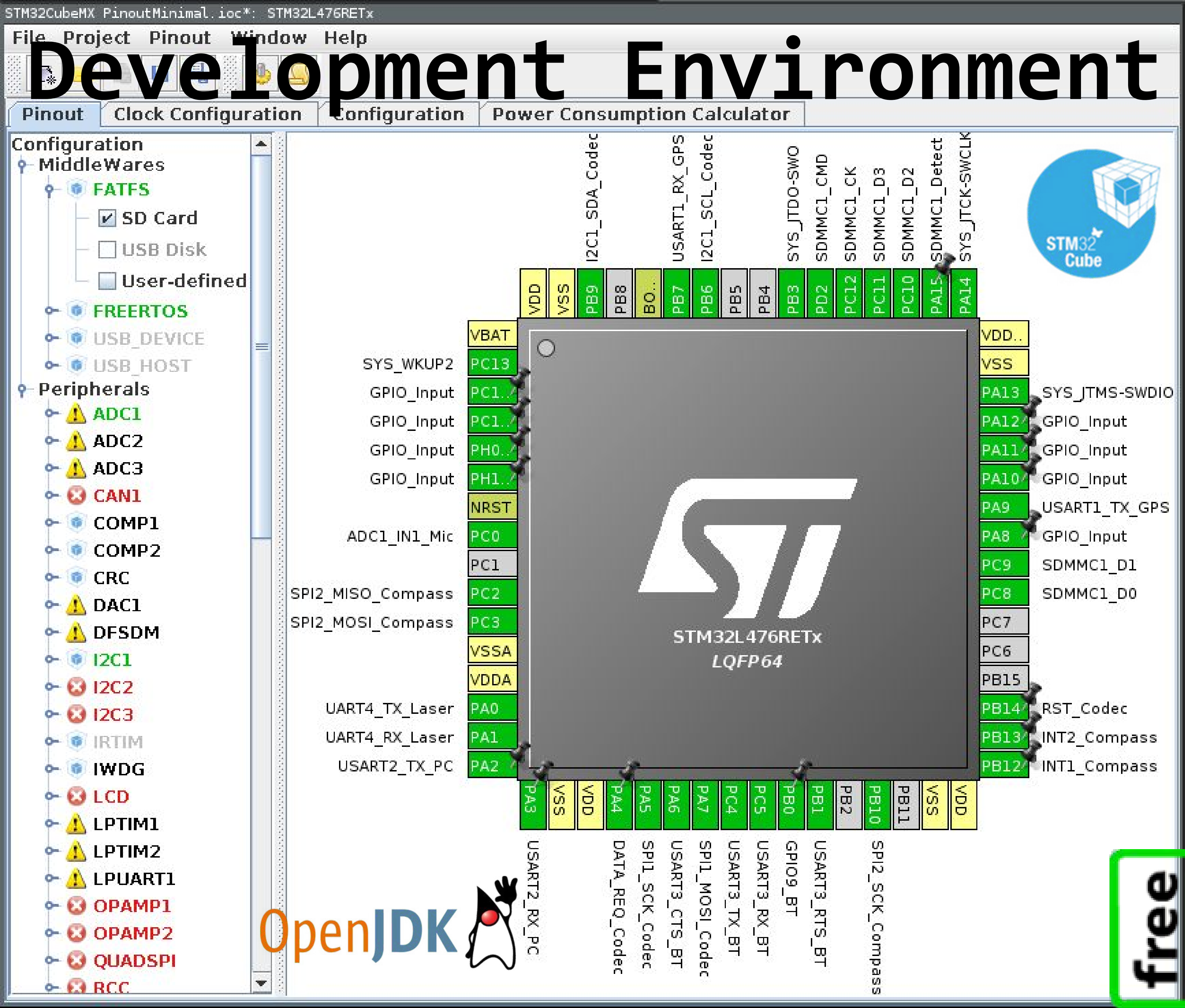
STM32L476

LQFP64	80MHz	128KB RAM	512KB-1MB Flash	ULP

mbed Enabled

Next:
Development
Environment

Development Environment



OpenSTM32

GCC, GDB, OpenOCD packaged as an **Eclipse** plugin

Pros: Free, open-source, cross-platform IDE.

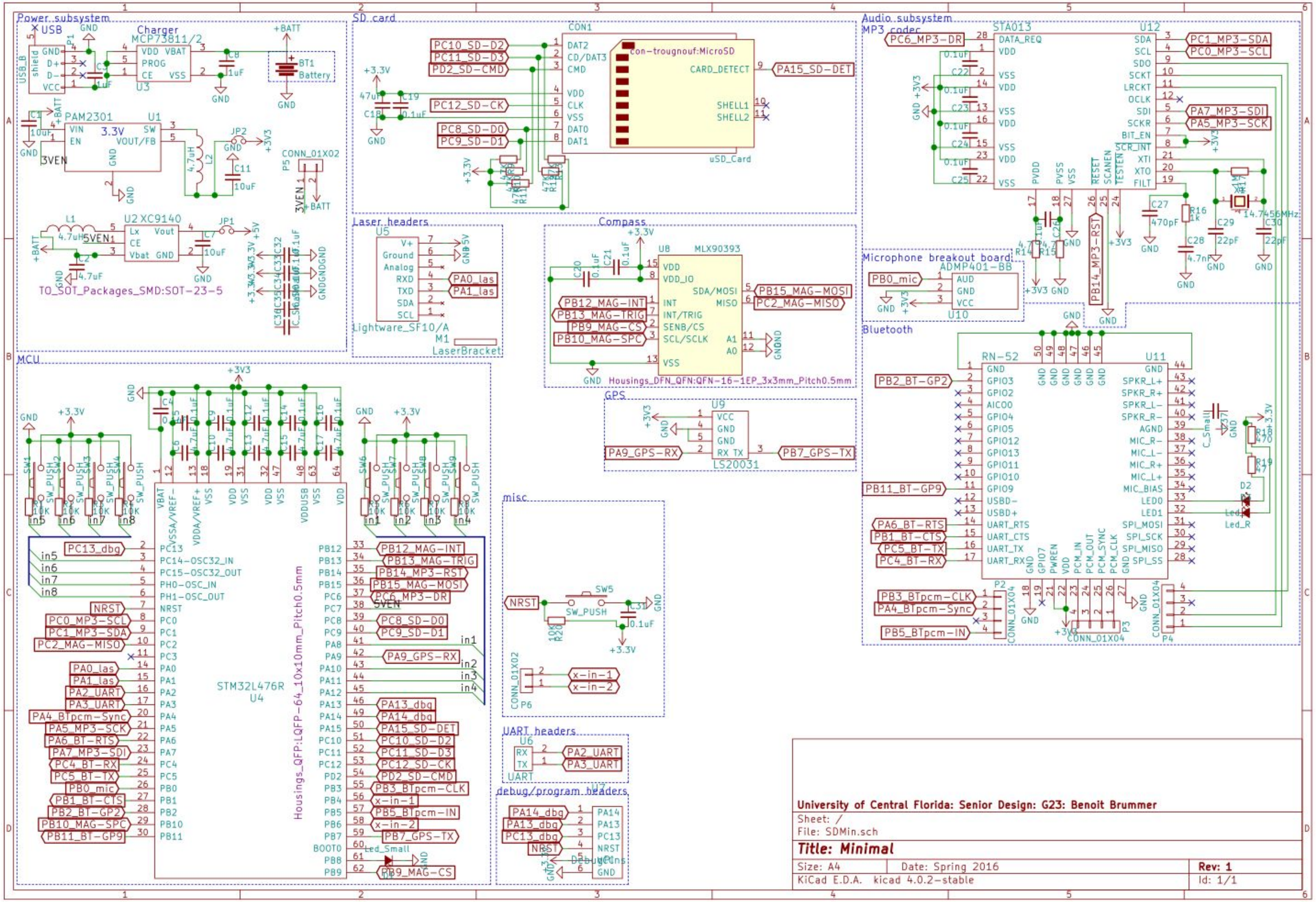
Cons: Not fully compatible with new STM32 L4

IAR Embedded Workbench

Pros: Compatible with newest STM32 L4 MCUs
Faster (C > Java)

Cons: Proprietary software
non-free, Windows-only

Sensewalk 9000 schematic



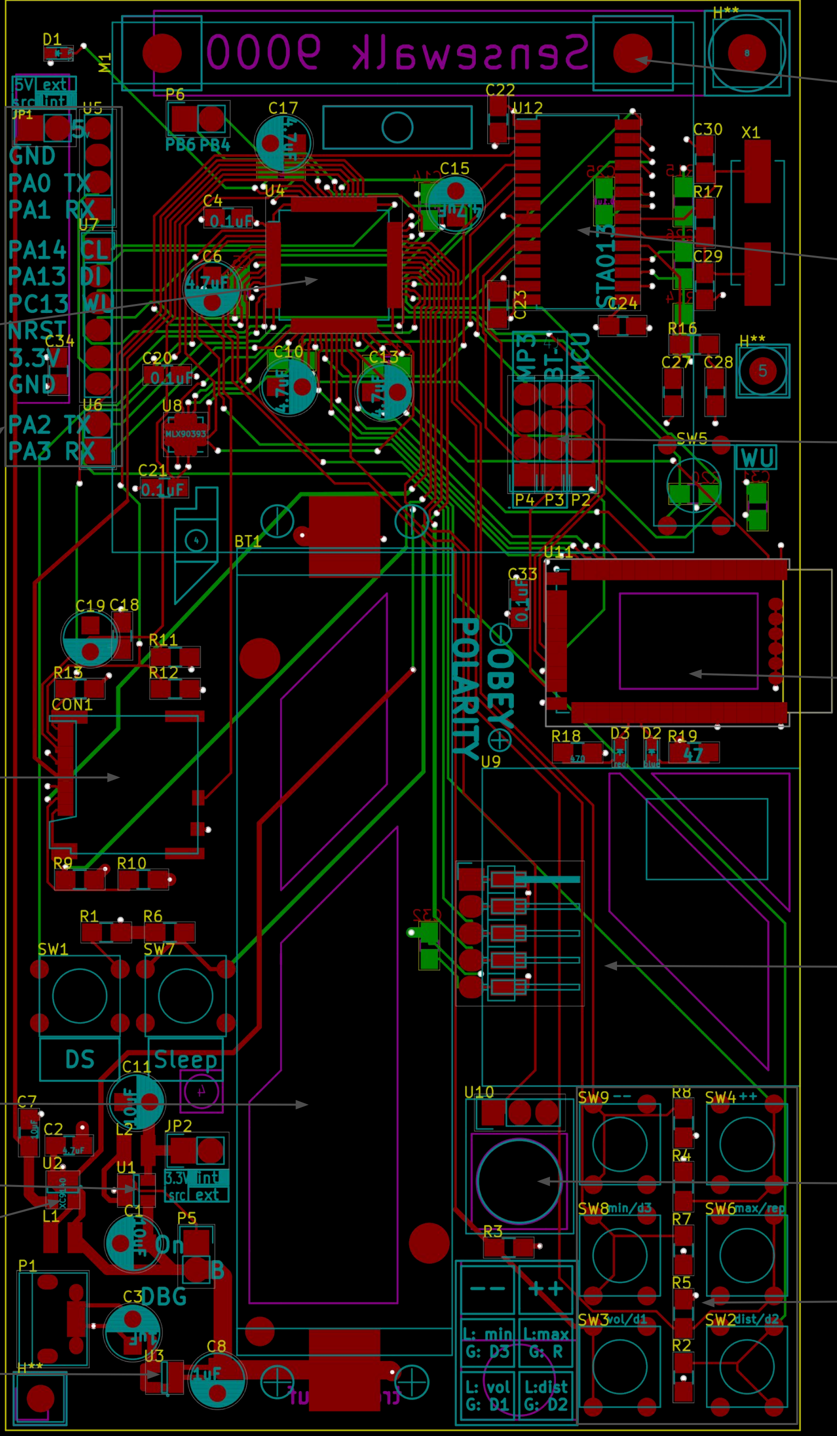
Sensewalk 9000 PCB layout

Microcontroller
STMicroelectronics STM32L476

Programming/debugging headers

MicroSD card
Molex 5033981892

Power subsystem
Lithium-ion rechargeable battery
18650 form-factor, user-replaceable
3.3V DC-DC switching regulator
Diodes Inc. PAM2301
5V DC-DC switching regulator
Skyworks AAT1217
Battery management (USB charger)
Microchip MCP73811



Laser / mount
LightWare SF10-A

Audio decoder
STMicroelectronics STA013

Software/hardware audio decoder switch

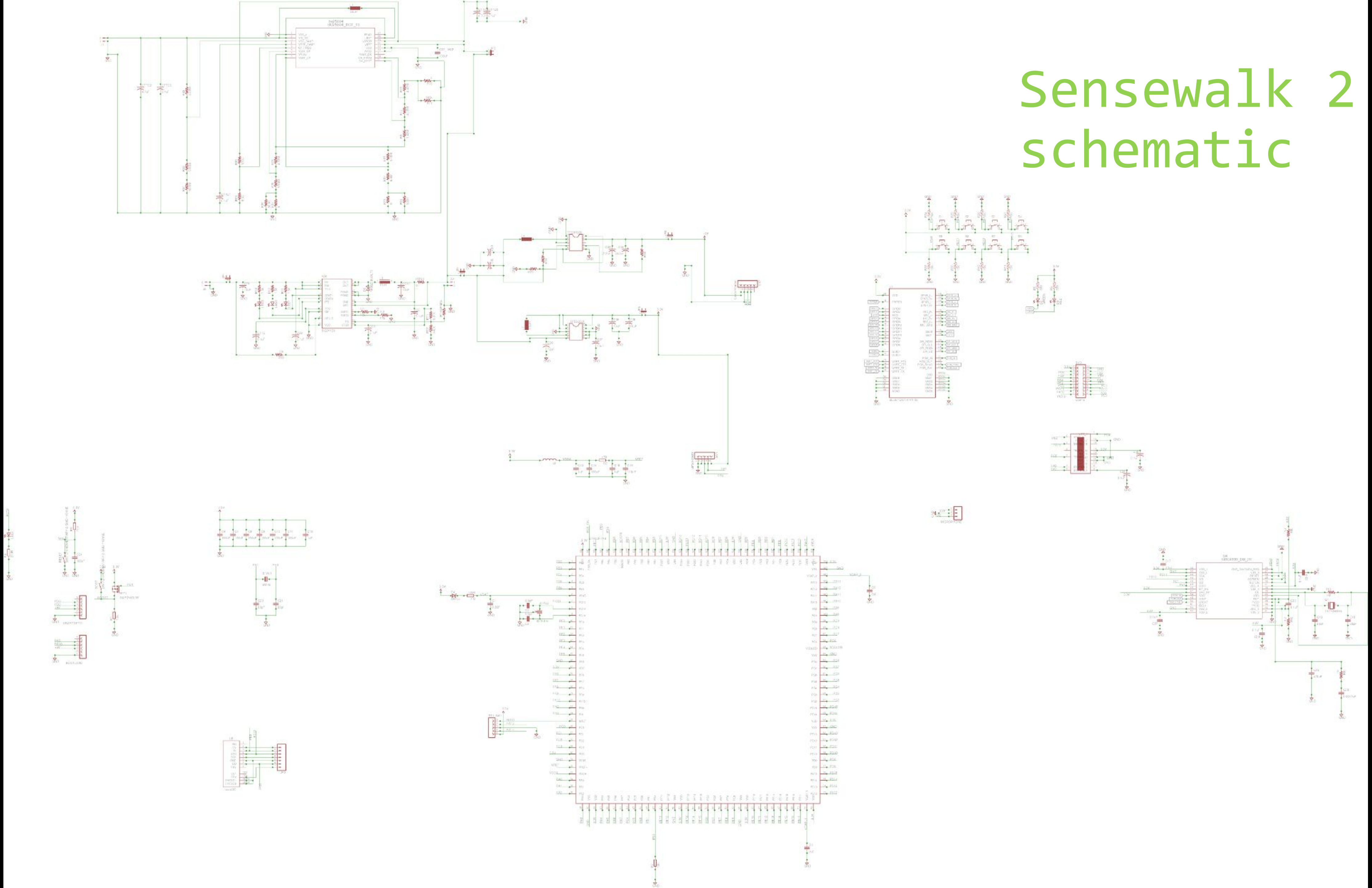
Bluetooth 3.0 module
Microchip RN52

GPS module
Locosys LS20031

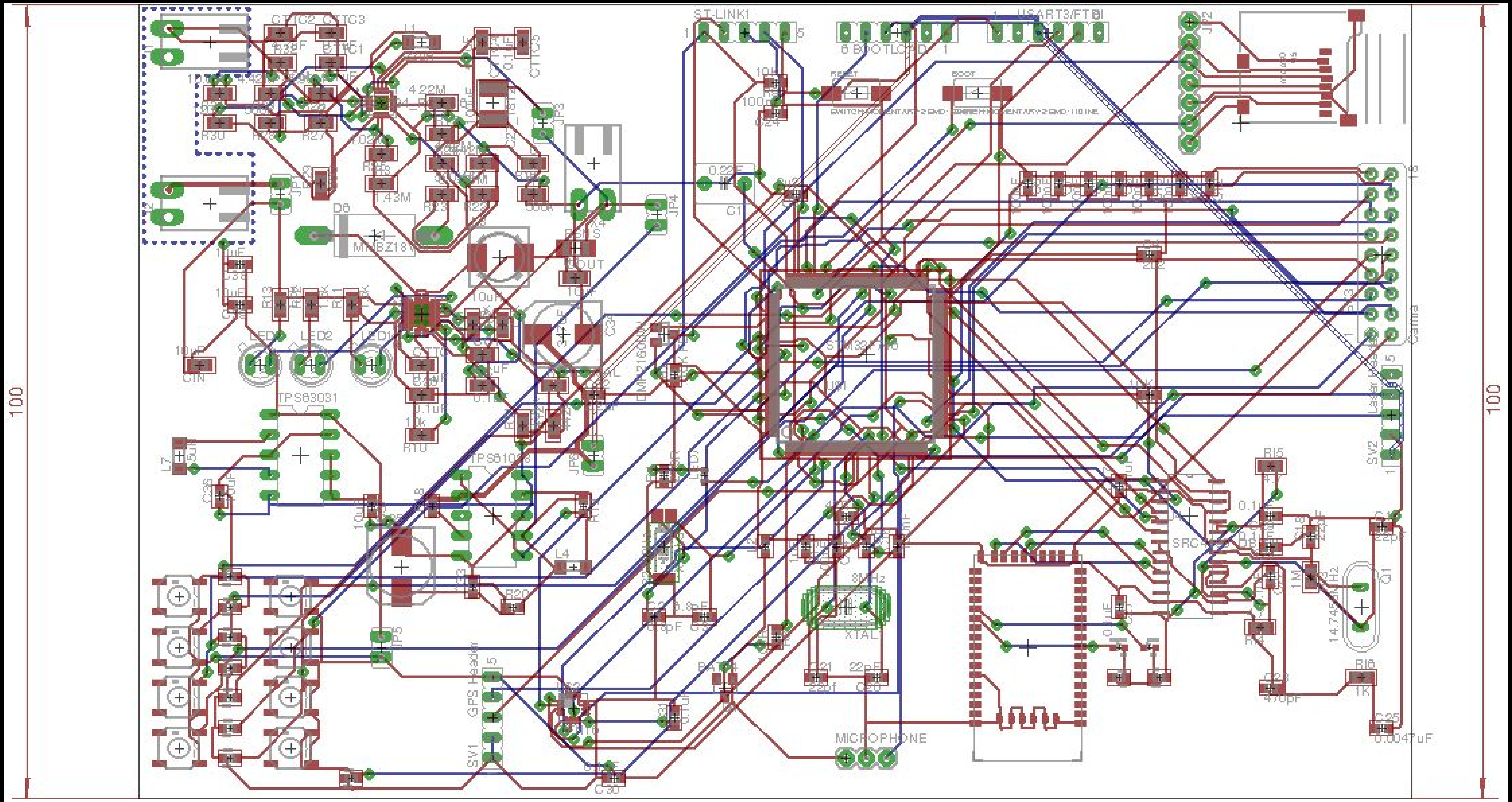
Microphone (MEMS)
STMicroelectronics ADMP401

Push buttons

Sensewalk 2 schematic



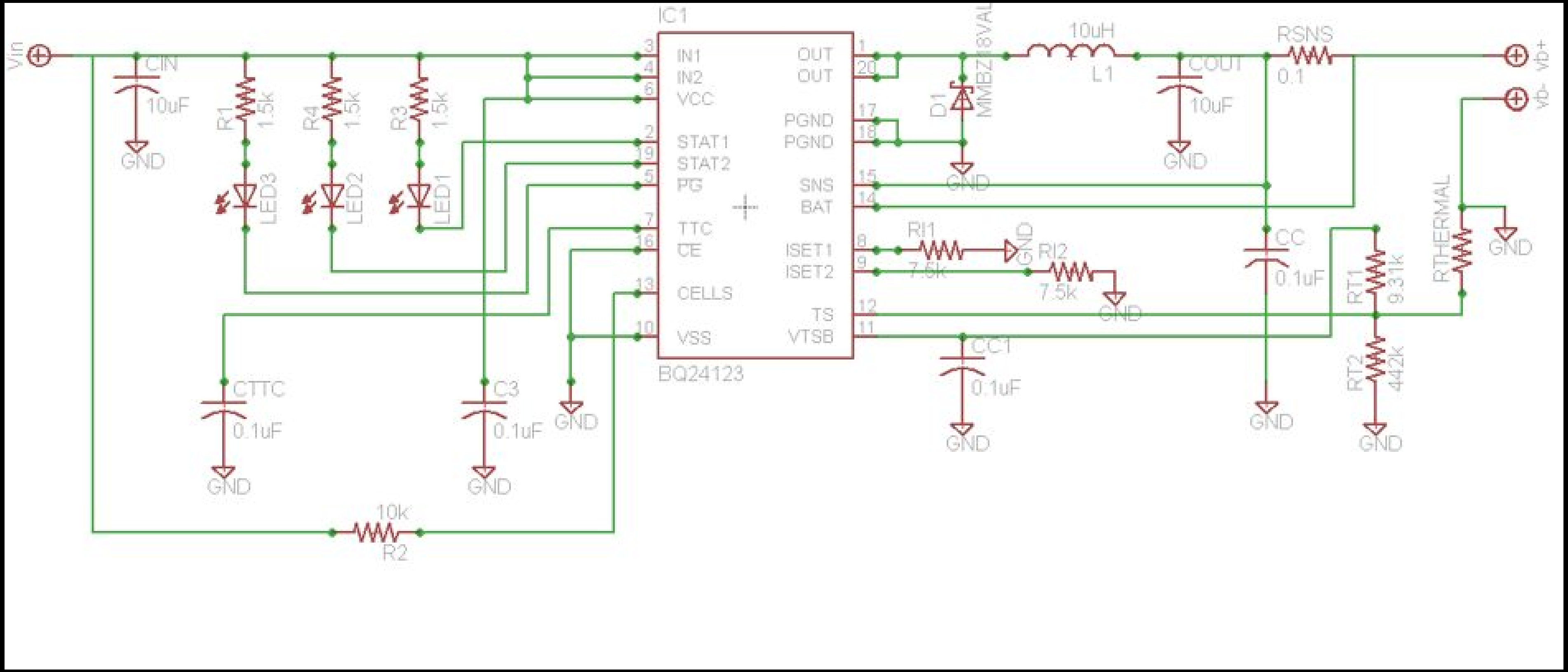
Sensewalk 2 PCB layout



Charging management

Solar cell and DC-DC charger BQ25504 Battery management evaluation board. solar cell charges at .45W and the DC-DC charger BQ24123 supports the charge of 3.7 volts.

Battery charger schematic



Videos

https://youtu.be/B0nTJOjk9Rg

https://youtu.be/O5-MO2XVdNk

https://youtu.be/q0PLyxzlnzM

https://youtu.be/VR2hmE7ErHA

Expenses

	Benoit	Chad	Diego	Ross	Funding
Laser					286.15
Development boards	121.98		40		21.98
PCB	95.74			X	
Bluetooth BB					89.9
GPS			70.37		
Audio decoder					58.35
Memory (unused)					45.51
Batteries / chargers	36				
MEMS microphone/breakout (unused)					27.8
Image sensors (unused)	25.58				
Debugger / programmer	24.51	3.20			
MicroSD sockets					20.36
Passive components	17.75				40.47
Bluetooth module	17.2				45.64
Breakout adapters	16.87				
Microcontrollers	15.76	28.47			37.96
Soldering consumables	14.89				
Power subsystem	12.45				
Magnetometers	8.05				25.02
Vibrator	4.64				12
LEDs	1.86				
Misc				X	10.5
Total	413.28	31.67	110.37		758.76

Distribution of Workload

Ross Applegate	Chad Borgelin	Benoit Brummer	Diego Merida
Power (Solar Panel & Lithium Battery integration)	Bluetooth audio output	Hardware components selection, development environment selection	GPS
Schematic Design (SW2)		Laser detection	
PCB Design (SW2)		Magnetometer	
		SD card / file system	
		Pinouts	
		Schematic design (SW9k)	
		PCB design (SW9k)	
		Boards bringup	
		Software integration	

Sponsors

Questions