Bike Dash

Group 11

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What is Bike Dash?

- An all-in-one ride monitoring application
- Consists of:
  - Sensors and Data Acquisition
  - Android application
  - Human power generation
- Target Audience
  - Ages 12+
  - Beginner to Advanced riders

Motivation

- Make riding easier to track
  - Catalog previous rides
  - Monitor progress during rides
- Visual progress encourages more riding
  - Trends and progress over time
- Challenge friends to ride
  - Post or “share” your ride with a friend

Objectives

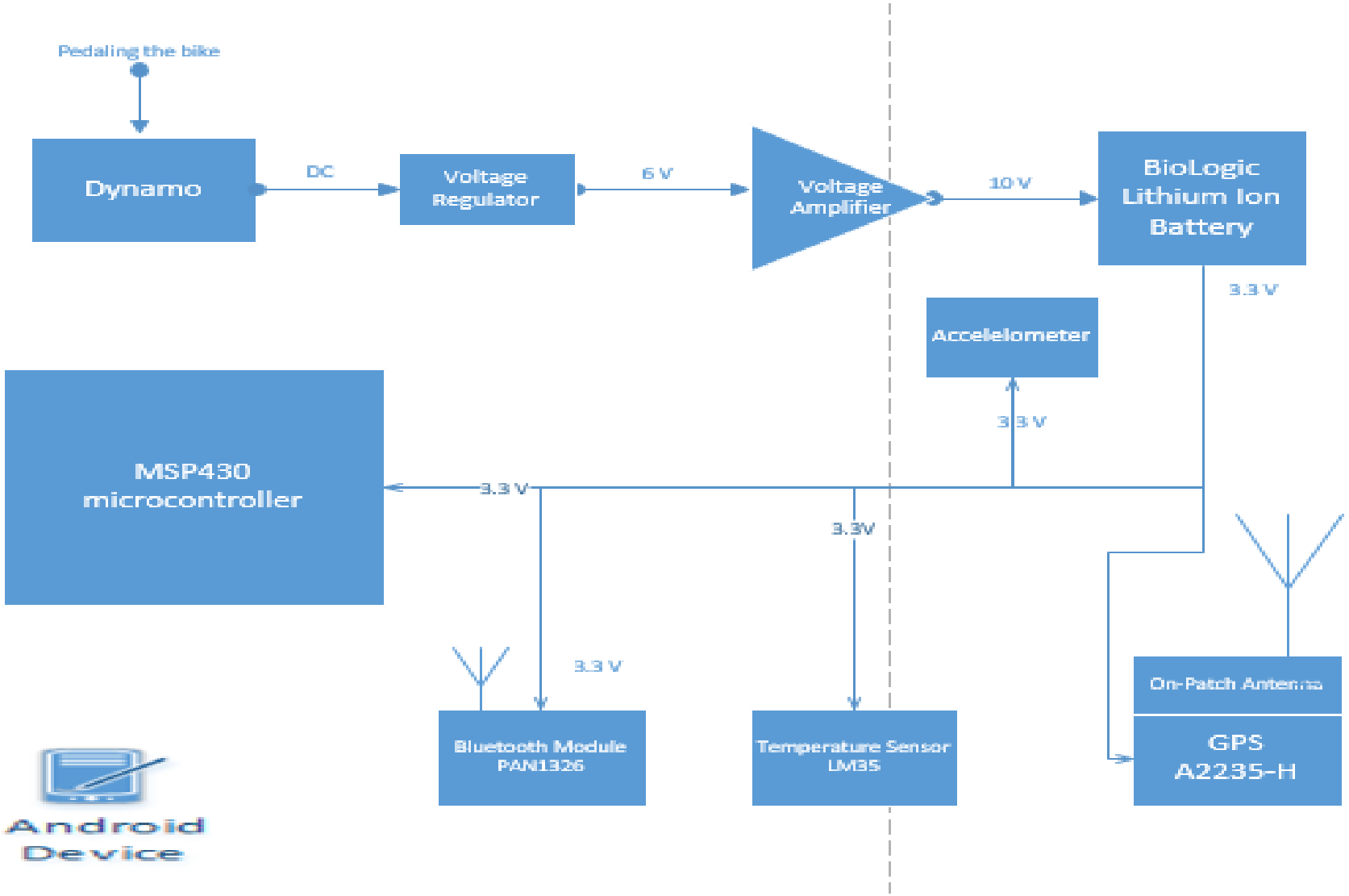
- Durability
  - Dust, water, and shock resistant
- Portability
  - Easy to remove
  - Lightweight
- Power Consumption
  - Under 3.0W
  - Rechargeable batteries

Expectations

To put that in numbers:

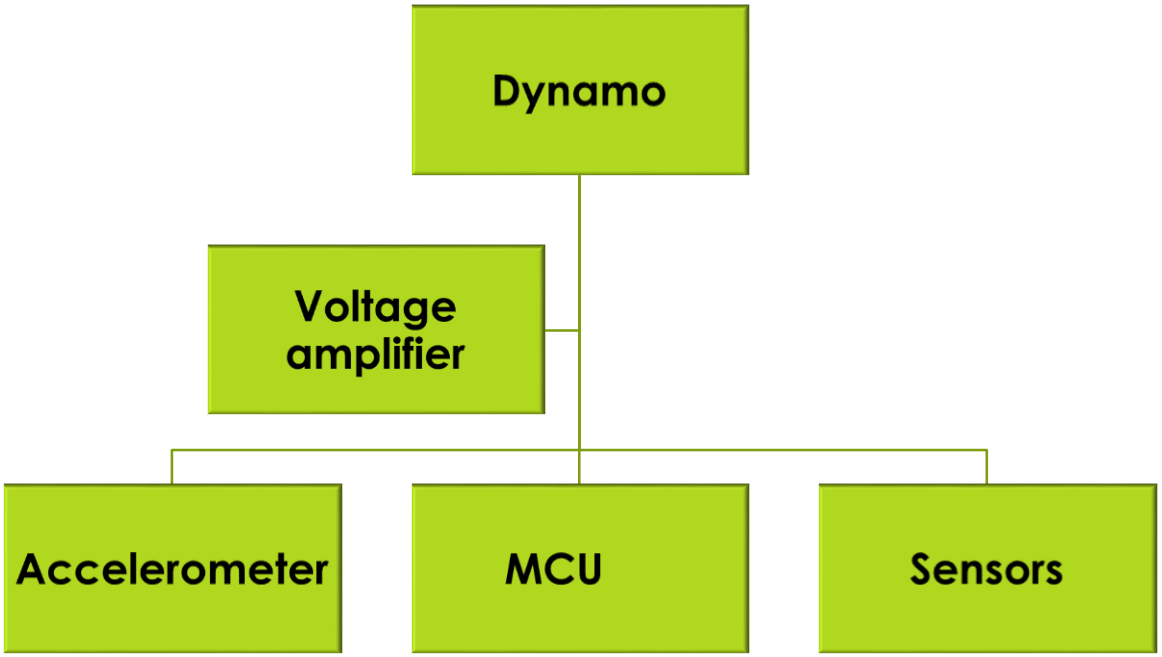
System Weight	< 4.5 kg
Power Supplied	3.0 W
Power Drawn	2.4 W
Operating Temperature	-20°C to 60°C
Dimensions	9 cm x 9cm x 5 cm (l x w x h)

Bike Dash Block Diagram



Power System

- Input voltage: 6V AC
- Full bridge rectifier: 10V DC
- Voltage regulator max. I/O: 67V / 10V
- Battery charger input voltage: 10V
- Output Voltages: 3.3V / 5V



Dynamo

	Shimano Alfine DH-3N80	**Joule 3**
Efficiency	70%	73%
Weigh	490g	355g
Spoke Hole	32	32
Over Lock-nut Dimension	100mm	100mm
Price	$139.95	$149.99

Shimano Alfine DH-3N80

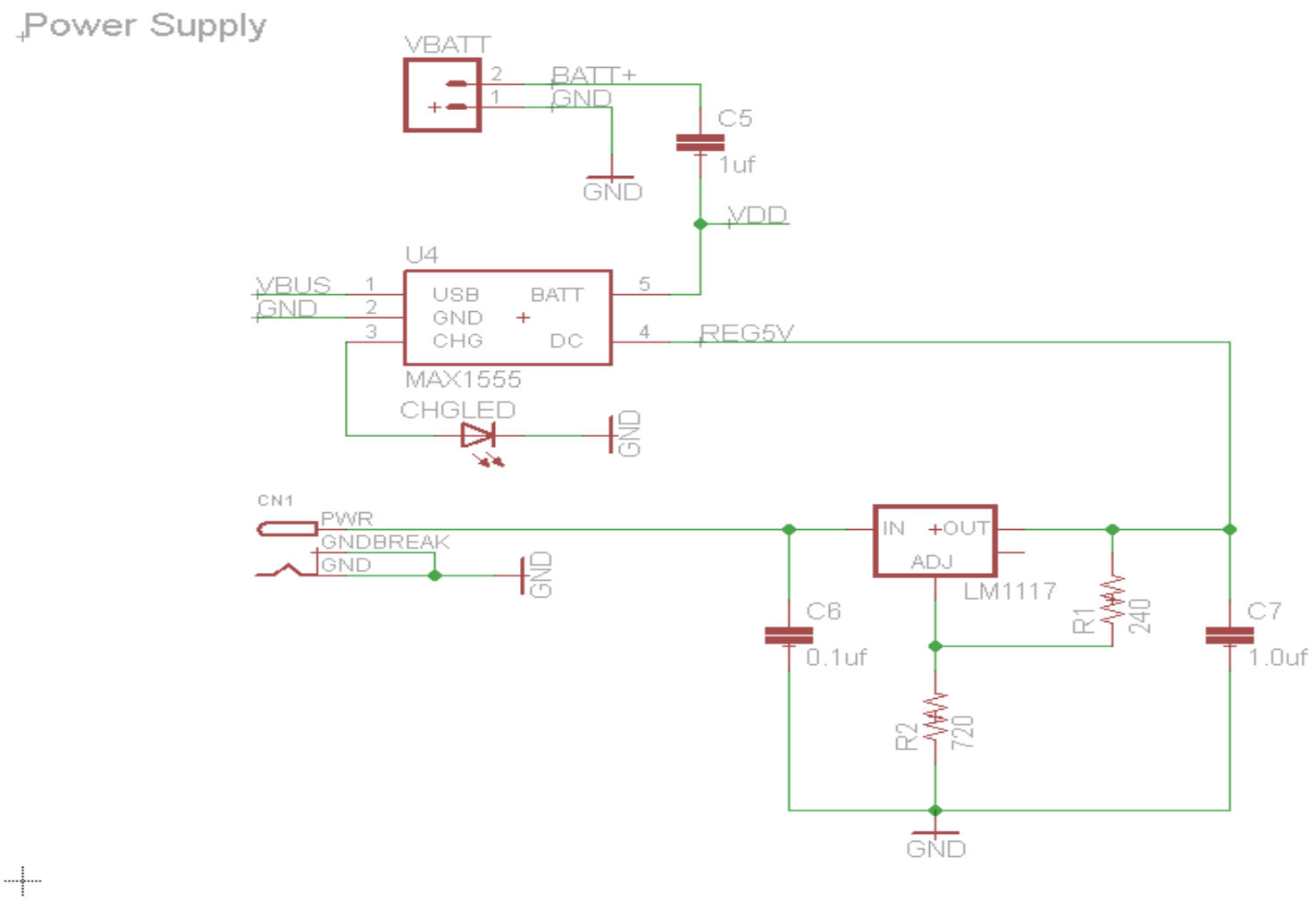
- Both hubs can shift under load. It shifts easier and smoother under high load and uphill.
- More gears can be shifted in one movement.
- Offer a disc brake and rim brake option.
- Uses the “easy click connector”.
- Power supply of 3 Watts.

Voltage regulator LM117

- Has 3 terminal adjustable regulators.
- Excess 1.5A over a 1.2V to 37V output range.
- Low cost and easy to use

	LM117
Fixed output options	1.8V – 5V
Noise	75 uVrms
V_{in} (max)	40V
V_{in} (min)	4.2V
Operating Temperature	-55 ^{o}C to +150 ^{o}C
I_q	1.5mA
Protection	Current limiting, thermal shutdown
Output Current	1.5A

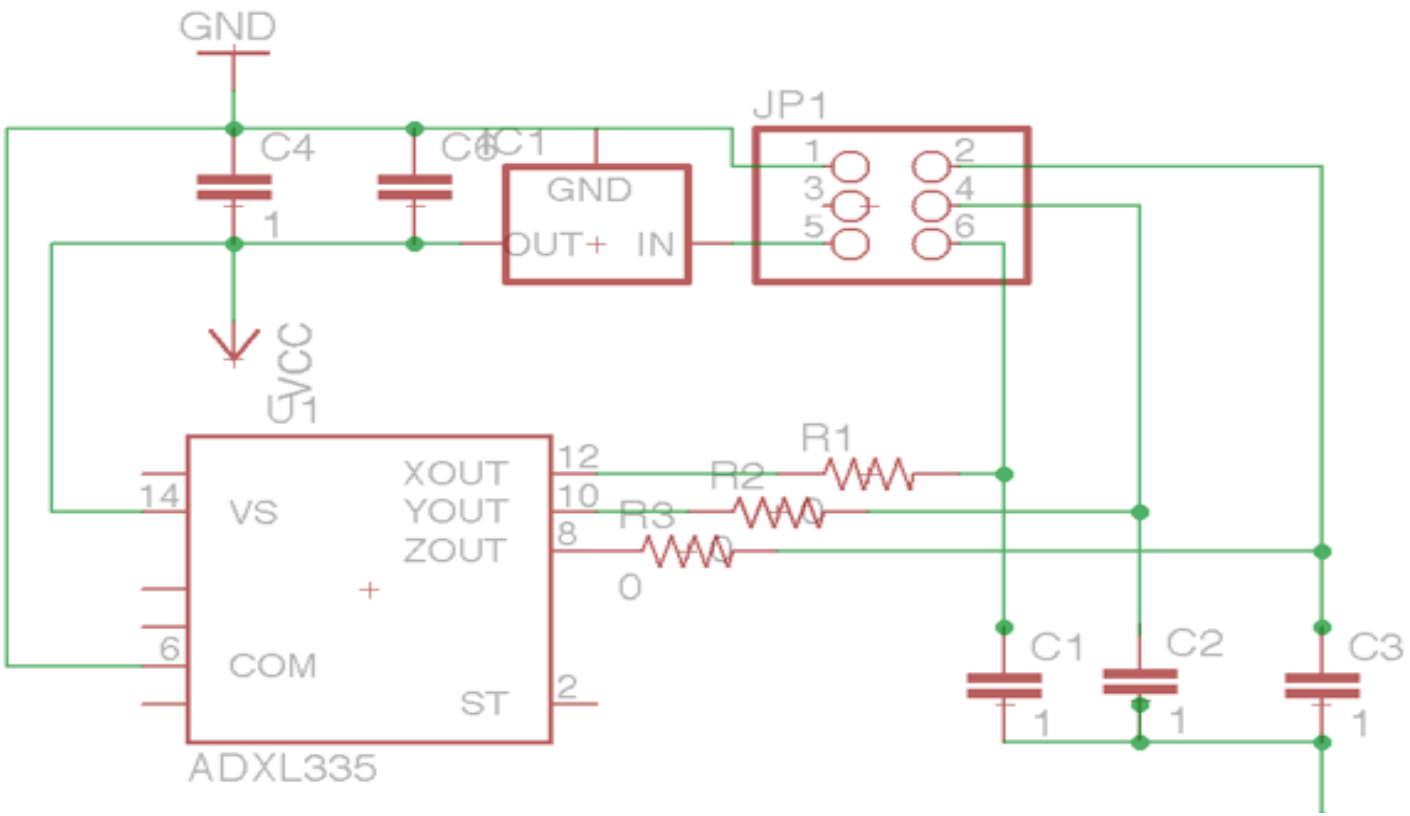
PCB Schematic for LM117



Accelerometer ADXL335

- Ultralow power consumption
- Very small and fit in PCB
- Has 3 axes accelerometer controls
- Wide voltage range between 1.8V to 3.6V
- Output data rate 12.5Hz and 400Hz
- Adjustable threshold for Motion Activation
- Has a built-in micro-power temperature sensor and several detection modes

PCB layout of ADXL335



Battery Pack

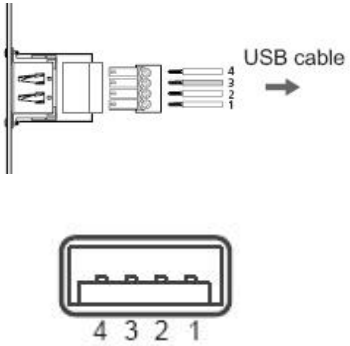
- **Works with most standard bicycle hub dynamos**
- **Directly charge devices via micro-USB**
- **Safety circuitry in power converter protects battery against power spikes**

Capacity	1600mAh
Voltage	7.4V
Dimension	2.63 x 1.45 x 0.7 (inch)
Weight	3.5 oz
Maximum charge current	2A
Maximum discharge current	5A
Cut-off voltage	4.8V

BioLogic Lithium Ion Battery

- Energy/Weight: 100Wh/0.104Kg
- Charge/Discharge Efficiency: 90-100%
- Durability: 24-48 months
- Cell voltage: 4.05V
- Capacity: 1600mAh
- Weight: 90g

USB



Parameter	Requirement
DC Voltage	4.5v – 6V
Maximum current (low power)	150mA
Max allowable input capacitance	10uF
Transfer Data Rate	5 Gbit/s

Pin #	Signal	Cable Color
1	+VCC	Red
2	Data -	White
3	Data +	Green
4	GND	Black

Wiring

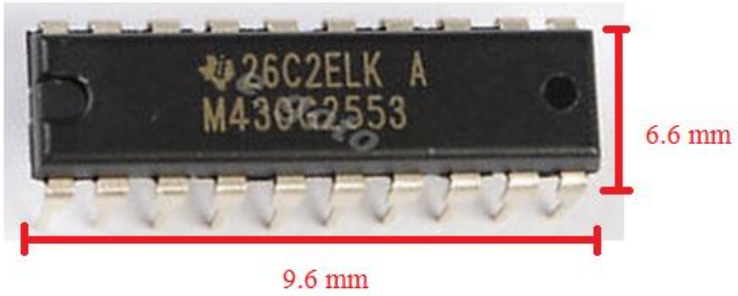
PCB Specifications

- Relatively low cost
- Low power consumption
- Requires approximately 5V to operate and consumes to 2W of power in active mode
- USB 3.0

Board length	3 in
Board width	4 in
Board thickness	0.06 in
Copper thickness outer later	0.0014 in
Minimum trace width	0.01 in
Minimum hole size	0.032 in

MSP430

- Low supply-voltage range
  - 1.8 V to 3.6 V
- Power Efficient
  - 16 MHz at 3.3 V
- 16-bit Architecture
  - Other MCUs we 8-bit



Other MCUs

ATmega48-20AU

Max Speed	**20 MHz**
Power (volts)	**5.5 V**
Size	**4.9 mm x 4.9 mm (L x W)**
Architecture	**8 – bit**
Operating Temperature	**-40ºC to 85ºC**

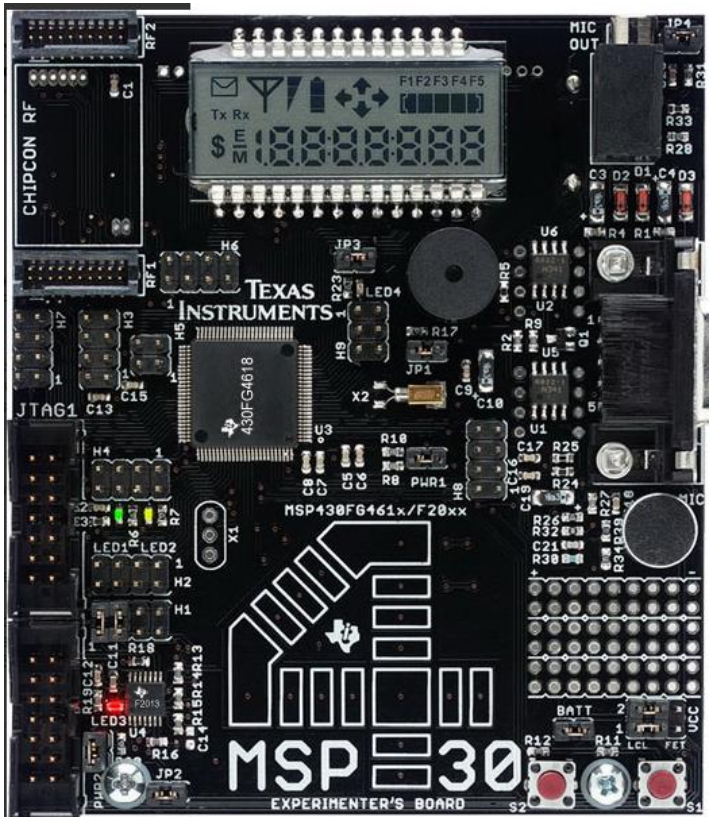
PIC18F14K22

Max Speed	**16 MHz**
Power (volts)	**5.5 V**
Size	**24.9 mm x 6.1 mm (L x W)**
Architecture	**8 – bit**
Operating Temperature	**-40ºC to 85ºC**

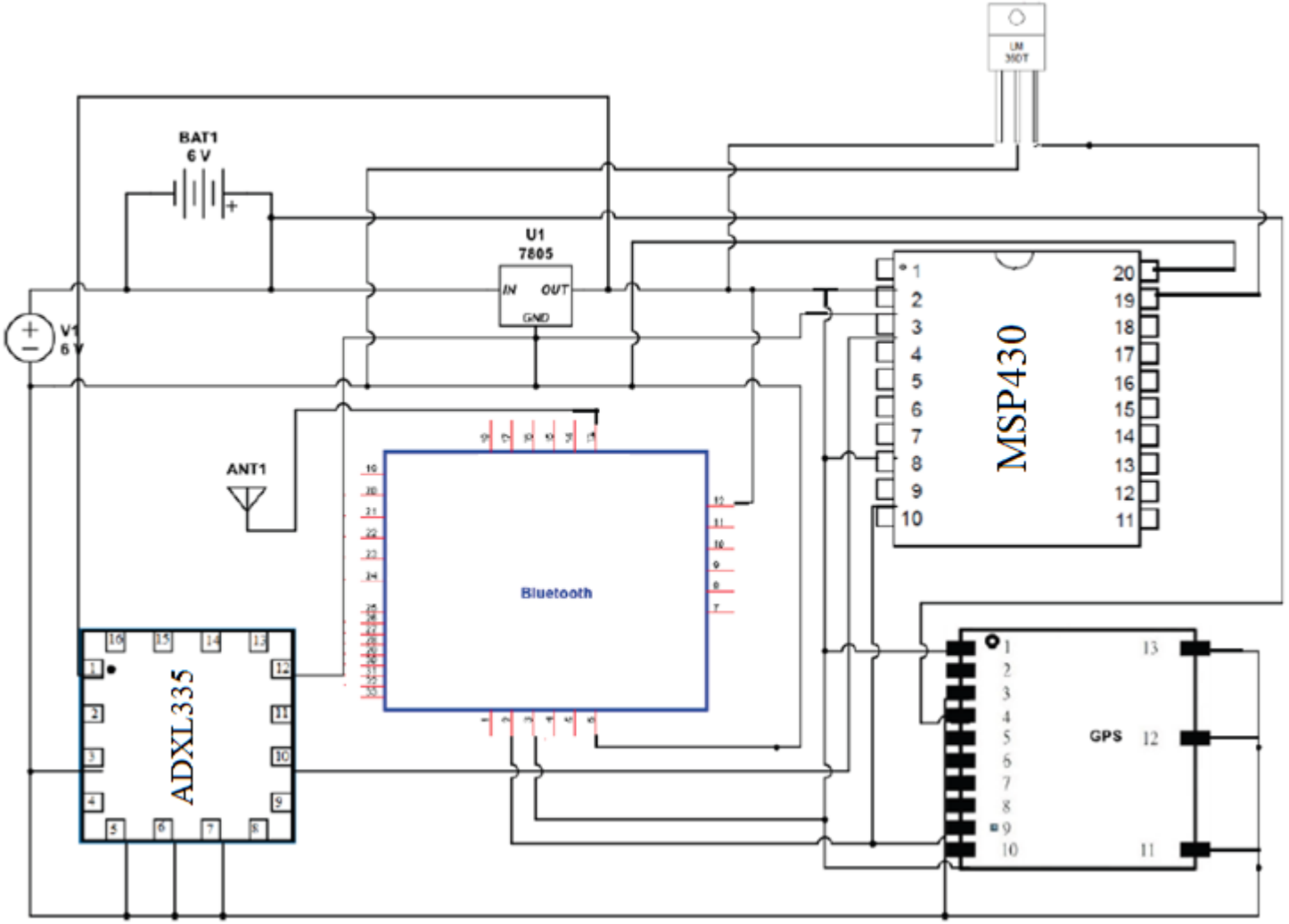
MSP430G2553 Operating Temperature: **-40ºC to 85ºC**

Programming the MSP430

- Versatility in programming language
  - C or Assembly
- Flash using Experimenter Board
  - We will use the MSP430FG4618
- Accept sensor input
  - Accelerometer, GPS, Temp
- Transmit data
  - Bluetooth



Integrating the MSP430



Temperature Sensor

- Broad temperature range
  - -55°C to 150°C
- Precision centigrade temperature sensor
  - Accurate to ±0.5°C
- Low voltage design
  - 3.3 V at room temperature (~20°C)

Other Temperature Sensors

Analog Devices TMP35

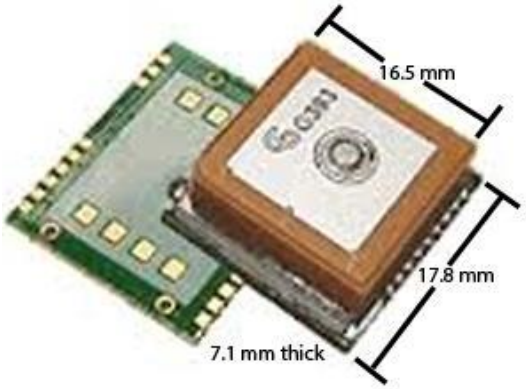
Temp. Range	**10ºC to 125ºC**
Voltage at ~20ºC	**3.6 V**
Accuracy	**±1ºC**

Honeywell TD5A

Temp. Range	**-40ºC to 150ºC**
Voltage at ~20ºC	**4.2 V**
Accuracy	**±0.4ºC**

GPS Receiver: A2235-H

- BT chip with an on-board patch antenna
  - Tuned to receive GPS L1 frequency for civilian use: 1.575 GHz
- Small & lightweight: 17.8 x 16.5 x 7.1 mm^3 , Weight: 4 g
- Ultra-low power consumption
  - Supply voltage of 3.3V and 31 mA average while tracking – (full power mode)
  - Hot start: < 1 sec. Cold Start: < 35 sec. Time To First Fix (TTFF)



GPS Receiver: A2235-H

- 48 channels, information read over UART serial port
  - Ports: Tx (NMEA output), Rx (NMEA) input
- An update rate of 1Hz is sufficient for tracking
- A2235-H configured by default to transmit serial data at baud rate of 4,800 bps, 8 data bits, no parity, 1 stop bit and no flow control

GPS Receiver:	
Serial Device	USART1
Transmit pin	TX0 (#18)
Receive pin	Rx0 (#19)
Baud rate	4800 bps
Frame Structure	8N1

Other GPS Receivers

	A2235-H	GMS-HPR	Venus638FLPx-L
Channels	48	66	65
Sensitivity (Tracking)	-163 dBm	-165 dBm	-165 dBm
Position Accuracy	< 2.5m CEP	< 2.5 m CEP	< 2.5 m CEP
TTFF Hot Start	< 1 s	< 1 s	< 1 s
TTFF Cold Start	< 35 s	< 33 s	< 29 s
Update Rate	1 – 6 Hz	1 – 10 Hz	1 – 20 Hz
Baud Rate Range	1,200 – 115.2 k	4,800 – 115.2k	4,800 – 115.2k
Supply voltage	3.0 – 3.6 V DC	3.0 – 4.3 V	2.8 – 3.6 V
Current Draw-tracking	29 mA	20 mA	11 – 18 mA
Power Consumption-tracking	86 mW	66 mW	60 mW
L x W x H (mm^3)	17.8 x 16.5 x 7.1	16 x 16 x 6.2	10 x 10 x 1.3
Weight	4.0 g / 0.14 oz.	6 g	1.8 g
Cost	$14.42	$20	$39.95 + antenna cost

Higher update rates

+

No antenna

=

High cost

First choice: could only order from China

Parsing GPS Information

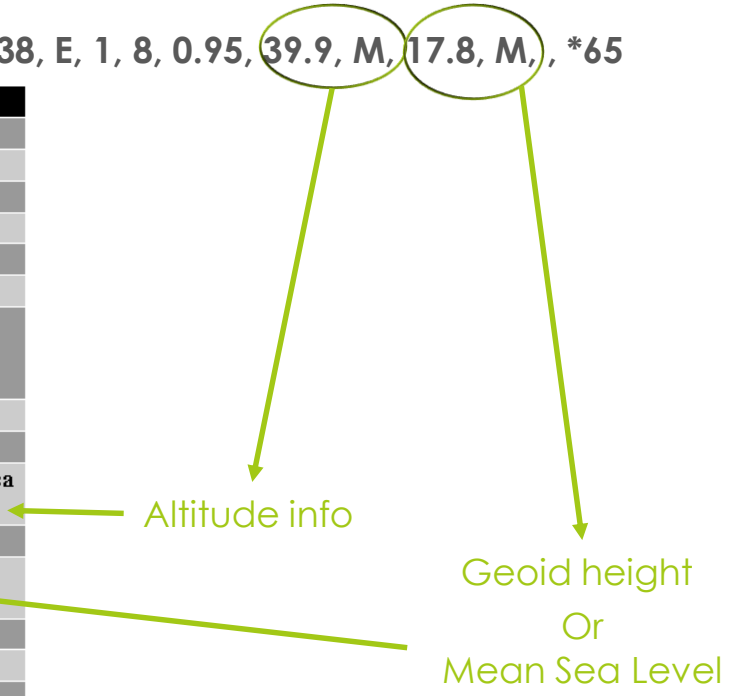
- There will be two NMEA output sentences used in the design
  - Recommended Minimum Navigation Information (RMC)
    - universal time (UTC), date, position, relative course and speed over ground
    - **$GPRMC, 064951.000, A, 2307.1256, N, 12016.4438, E, 0.03, 165.48, 260406, 3.05, W, A*2C**

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	064951.000		hhmmss.sss
Status	A		A = data valid or V = data not valid
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12016.4438		ddmm.mmmm
E/W Indicator	E		E = east or W = west
Speed over Ground	0.03	knots	
Course over Ground	165.48	degrees	True
Date	260406		Ddmmyy
Magnetic Variation	3.05, W	degrees	E = east or W = west
Mode	A		A = Autonomous mode D = Differential mode E = Estimated mode
Checksum	*2C		
<CR> <LF>			End of message termination

Parsing GPS Information

- And Global Positioning System Fixed Data (GGA)
  - altitude above or below mean sea level
  - **$GPGGA, 064951.000, 2307.1256, N, 12016.4438, E, 1, 8, 0.95, 39.9, M, 17.8, M, , *65**

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Time	064951.000		hhmmss.sss
Latitude	2307.1256		ddmm.mmmm
N/S Indicator	N		N = north or S = south
Longitude	12016.4438		dddmm.mmmm
E/W Indicator	E		E = east or W = west
Position Fix Indicator	1		0 = Fix not available 1 = GPS fix 2 = Differential GPS fix
Satellites Used	8		Range 0 to 14
HDOP	0.95		Horizontal Dilution of Precision
MSL Altitude	39.9	meters	Antenna Altitude above/below mean sea level
Units	M	meters	Units of antenna altitude
Geoidal Separation	17.8	meters	
Units	M	meters	Units of geoids separation
Age of Diff. Corr.		second	Null fields when DGPS is not used
Checksum	*65		
<CR> <LF>			End of message termination



Bluetooth Module: PAN1326

- HCI data packets are to Android device using short wavelength radio transmissions
  - Frequency Band Range: 2400-2483.5 MHz

- Based upon TI's CC2564 BT Host Controller Interface, with attached antenna
  - RF-Receive Sensitivity: Up to -93 dBm, Tx Power: 10 dBm
- Dual-mode: BT 2.1 + EDR and BLE v4.0
- **Class 2 Specifications**: range of up to 33 ft. (10 m) and max permitted power of +10 dBm
- Dimension: 9 x 9.5 x 1.8 mm^3 Weight: 0.25 g

Bluetooth Module: PAN1326

- Ultra-low power consumption
  - Bluetooth Low Energy (BLE 4.0) → fast connections (few ms)
  - Current consumption: Active mode: 40 mA
  - Supply voltage: 3.3 V
- Flexibility for Easy Stack Integration and Validation with MSP430™
  - TI's royalty free BT stack: *Stone Street Blue Topia stack*
  - *MSP430 can run both BT stack and embedded application*

Bluetooth	
Transmit Pin	HCI_TX (#6)
Receive Pin	HCI_RX (#5)
Baud Rate	115.2 kbps
Frame Structure	8N1

Heart Rate Sensor: Scoche RHYTHM

- Heart rate chest strap with Bluetooth capabilities (Class 2: range = 33 ft.)
- Helps riders.
  - Maintain safety, monitor progress, maintain target zone
- Compatible with Android devices

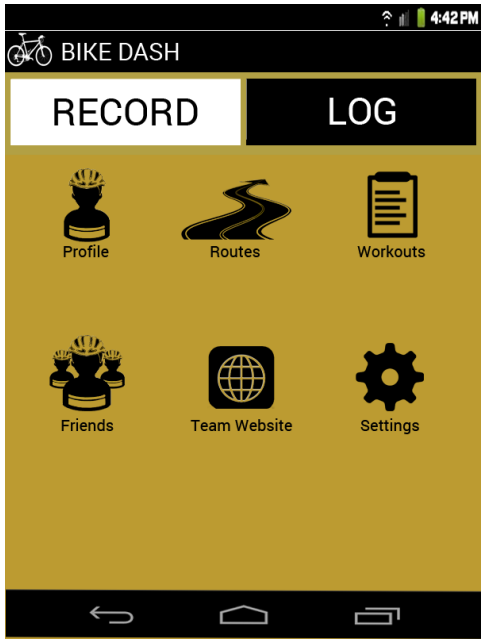
	Scoche RHYTHM	Polar H7
Heart Sensor Style	Chest Srap	Chest Strap
Bluetooth Enable	Yes	Yes
Bluetooth Certification	FCC	FCC, IC, CE
Battery Life	6 hours	200 hours
Operating Temperature	0 °C to +45 °C	-10 °C to +50 °C
Dimensions ($inches^3$)		8 x 1.5 x 5
Weight (oz.)		1.6
Cost	$ 35.00	$ 69.99

Android Application

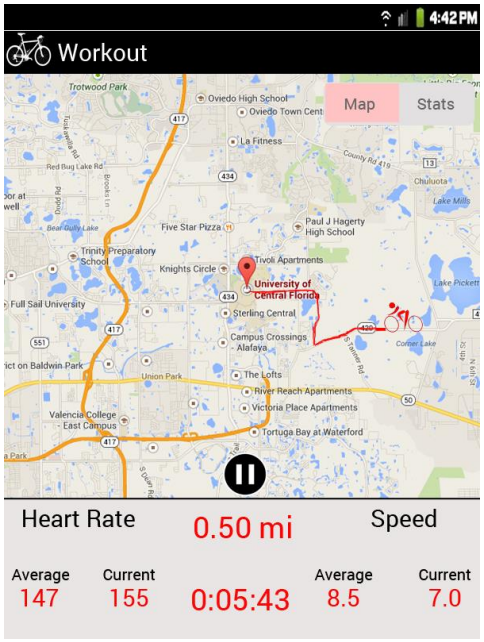
- Used to displays information to the rider
  - Speed, Duration, Elevation, Distance, Calories, Heart Rate, Map
- Information will be received via HCI packets broadcasted over Bluetooth Network
- Portability: *Gingerbread* (API 10) through *Kit Kat* (API 19) = 98.7% of devices
- Positive user experience
  - audio and visual feedback
  - Two view options: Map view and Stats view
  - Familiar application layout (Twitter)

Android Application: User Interface

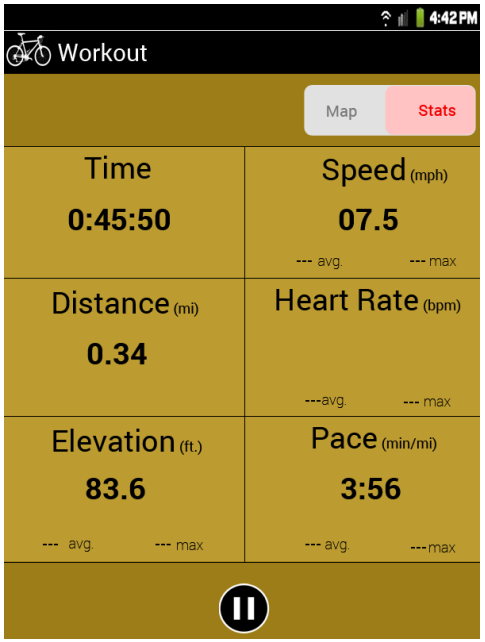
Main Menu



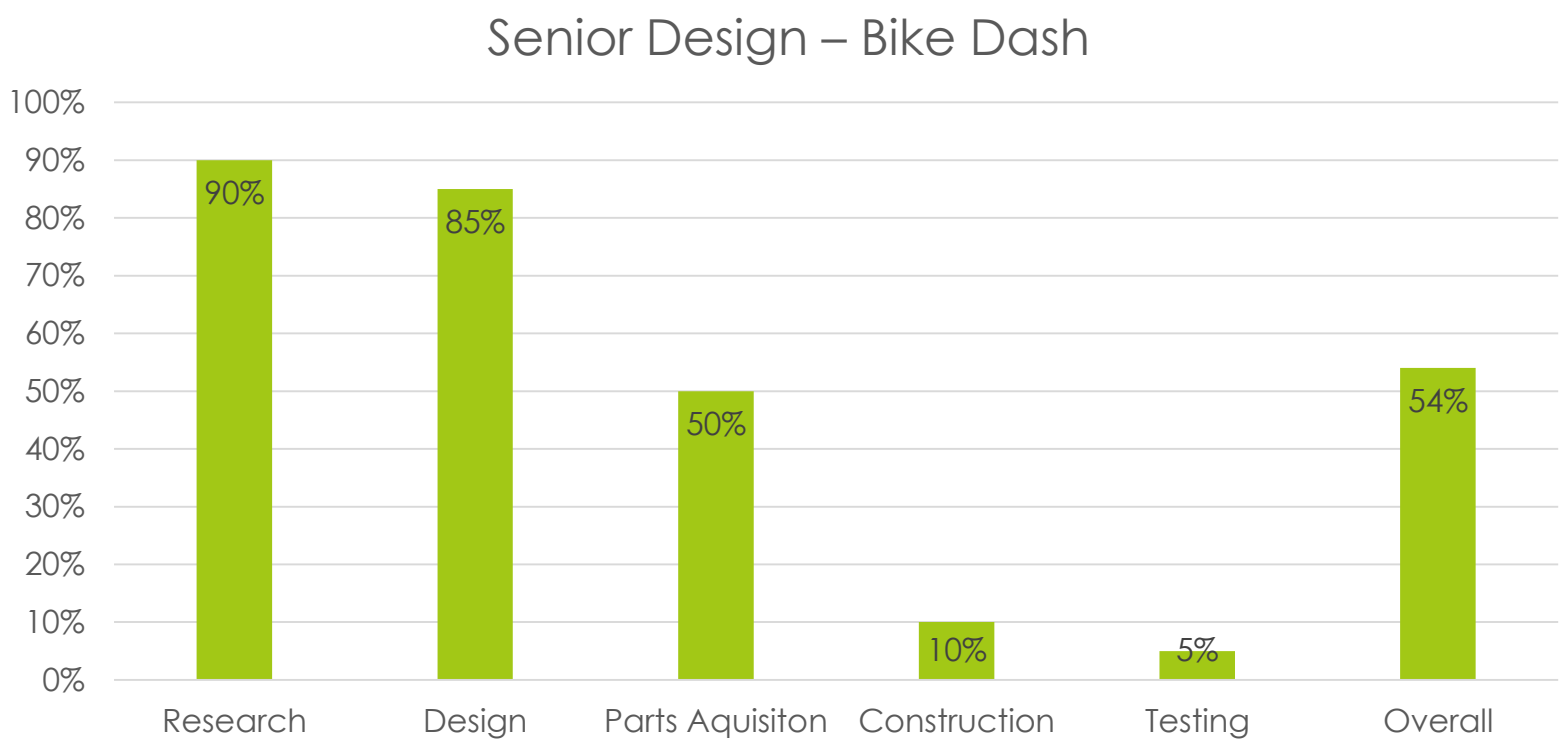
Map View



Stat View



Current Progress



Moving Forward

- Begin building first week of February
- Have PCB designed and ordered by end of February
- Android application completed by mid-March
- MCU architecture complete by March
- Begin testing by April 1, 2014

Project Budget

Part	Part #	Price	Acquired	
Bluetooth	BT-PAN1326	$28.85		
Heart Rate	Scoche RHYTHM	$39.95		
GPS	A2235-H	$24.41		
Temperature Sensor	LM35-DZ	$17.00		
Microcontroller	MSP430	$10.00		
Experimenter's Board	MSP430FG4618	Free		
Dynamo	Shimano Dh-3N80	$98.44		
Accelerometer	ADXL-352	$9.22		
Bike	----	$20.00		
Current Total : $247.87		**Budget: $ 578.08**		

Questions?