THE INCREDIBLE HUD

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Outline

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- Block diagram
- Component failure calculations
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- High/Medium-Level Failures
- Software design/development status
- Project completion timeline
- Questions/Discussion

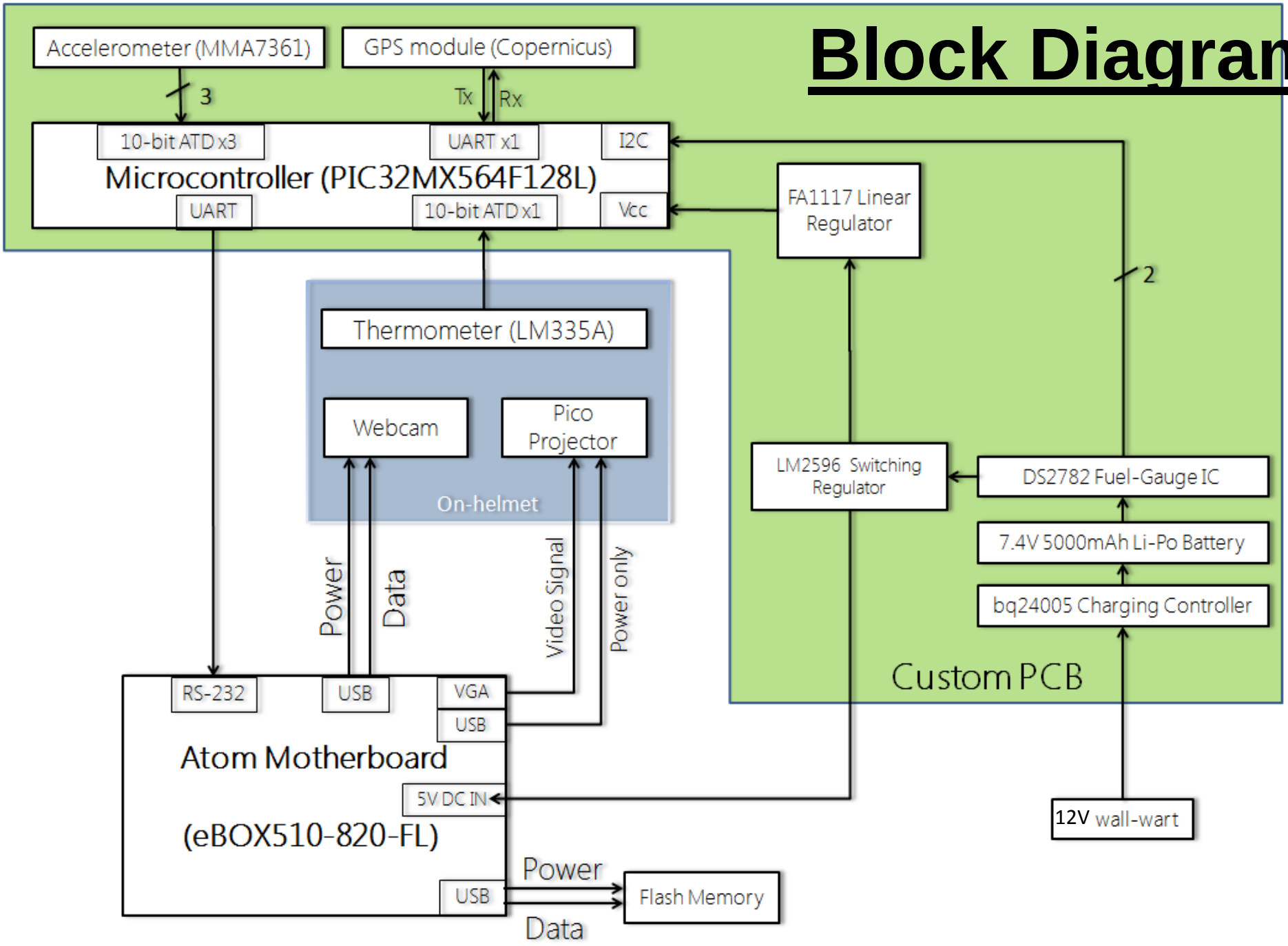
Project Overview

- Helmet-based heads-up display
- Displays telemetry data such as speed, direction, temperature, and G-force
- Displays image from web camera to implement a “rear view mirror”
- The user can select different display modes
- An accelerometer, GPS module, and thermometer will generate telemetry data
- Data will be recorded onto SD card to allow for future review
- The battery pack, motherboard and primary PCB will be located in a secondary backpack enclosure

Project-Specific Success Criteria

1. An ability to display critical system information via a heads-up-display (HUD).
2. An ability to measure telemetry information (speed, acceleration, temperature, and GPS) and store it to flash memory.
3. An ability to maintain portability through the use of a rechargeable battery system.
4. An ability to enable/disable important features within the display (full information, minimal, on/off).
5. An ability to plot recorded GPS data on a map while overlaying telemetry information on a

Block Diagram



Component Failure Times

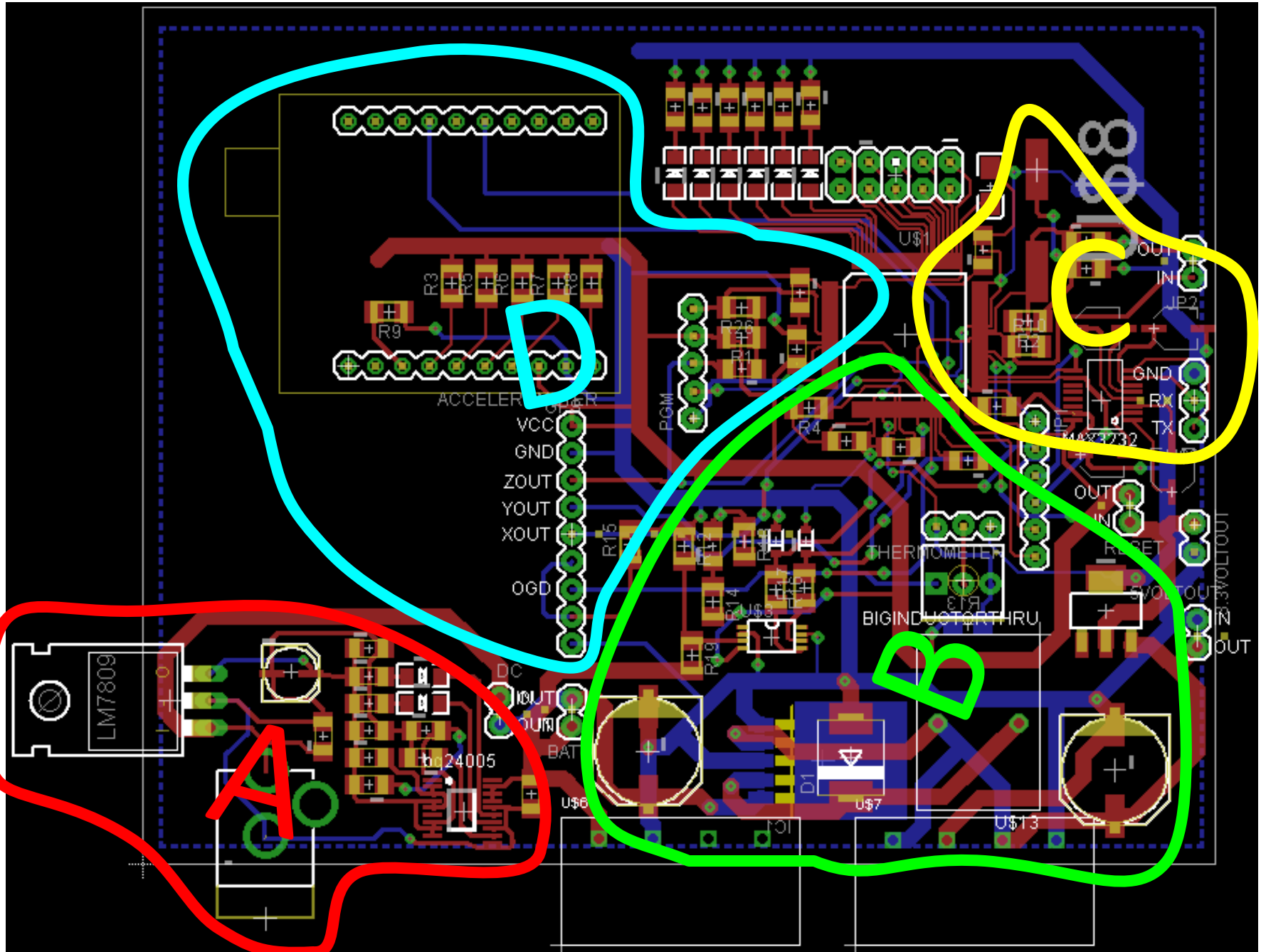
5V Switching Regulator			
λ_b	Type	.012	Assume MOSFET
π_T	Temperature coeff.	3.7	T = 100°C
π_A	Application	2.0	2-5W Power FET
π_E	Environment factor	9.0	Ground mobile
π_Q	Quality factor	10	Unknown
$\boldsymbol{\lambda_P}$	Failures/10^6 hours	7.992	
MTTF	Mean time to failure	125,125 hrs	
Microcontroller			
C_1	Die complexity	0.56	32-bit
π_T	Temperature coeff.	0.19	Junction temperature = 40°C
C_2	Package failure	< 0.068	Pins = 128
π_E	Environment factor	4.0	Ground mobile
π_Q	Quality factor	10	Unknown
π_L	Learning factor	1.0	>2 years in production
$\boldsymbol{\lambda_P}$	Failures/10^6 hours	3.784	
MTTF	Mean time to failure	264,271 hrs	
Battery Charging IC			
C_1	Die complexity	0.56	32-bit
π_T	Temperature coeff.	0.84	Junction temperature = 80°C
C_2	Package failure	< 0.01	Pins = 22
π_E	Environment factor	4.0	Ground mobile
π_Q	Quality factor	10	Unknown
π_L	Learning factor	1.0	>2 years in production
$\boldsymbol{\lambda_P}$	Failures/10^6 hours	5.104	
MTTF	Mean time to failure	195,925 hrs	

Failure Groups

4 Failure Groups:

A. battery charging circuit
B. fuel gauge circuit
C. oscillator and line-level converter
D. sensors

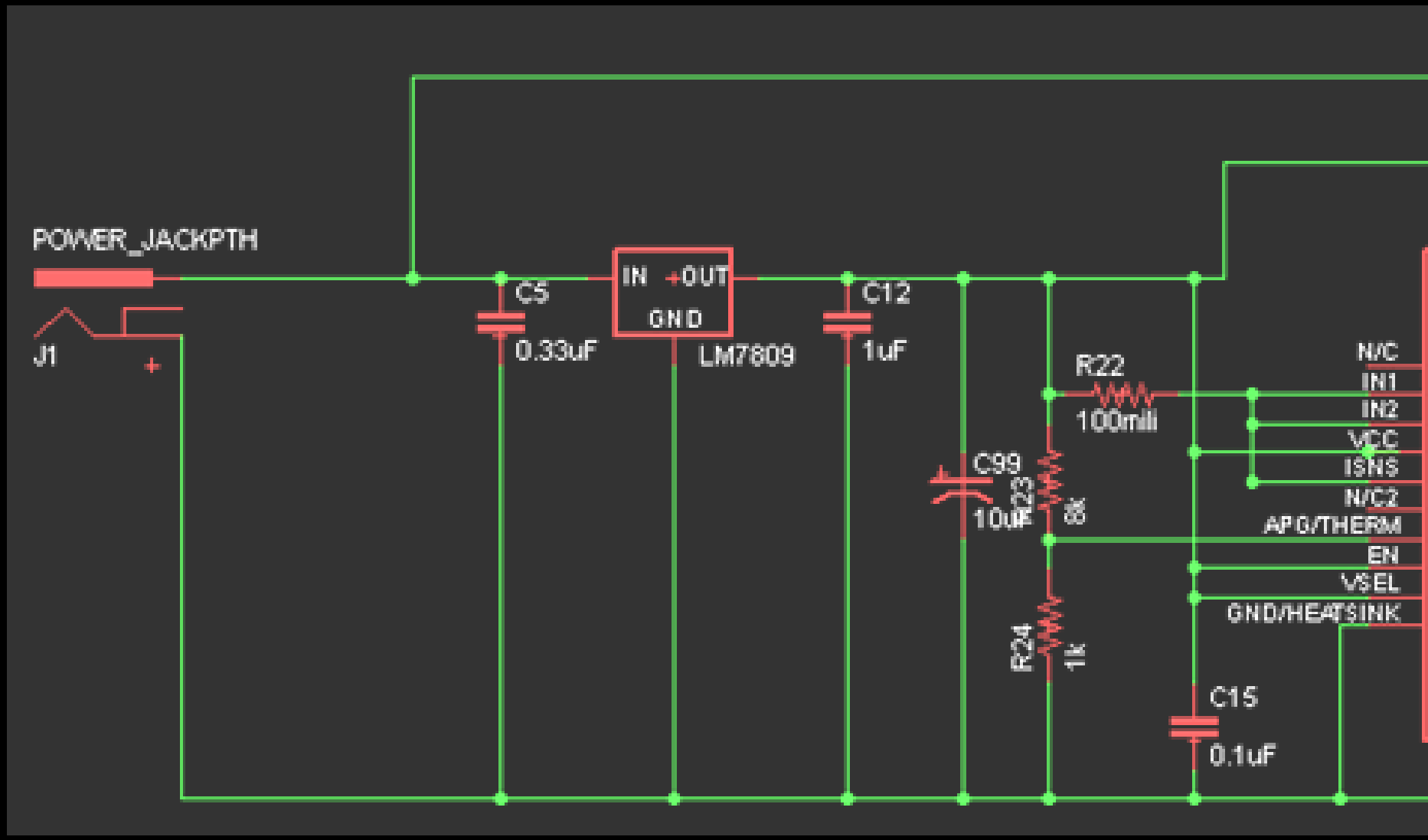
Failure Groups



High/Medium Level Failures

A-2	Battery overheats and/or catches fire/explodes	Battery fuse shorted and/or internal safety measures to battery fail AND charging IC fails to detect battery charge level (battery and battery charging IC failures)	Battery overheats and potentially catches fire (explodes)	Intense heat followed by potential flaming / exploding battery	High	Absolute worst case scenario for this device
A-3	Battery does not charge to proper level or at all	Battery charging IC failure, LM7809 failure	Battery will not charge or will not charge to full 8.2 volts, possibly no/low voltage on 9v rail	Measure battery voltage, measure 9v output rail, measure voltage across R22	Medium	R22 is a 0.1Ω sense resistor that detects current output to battery.

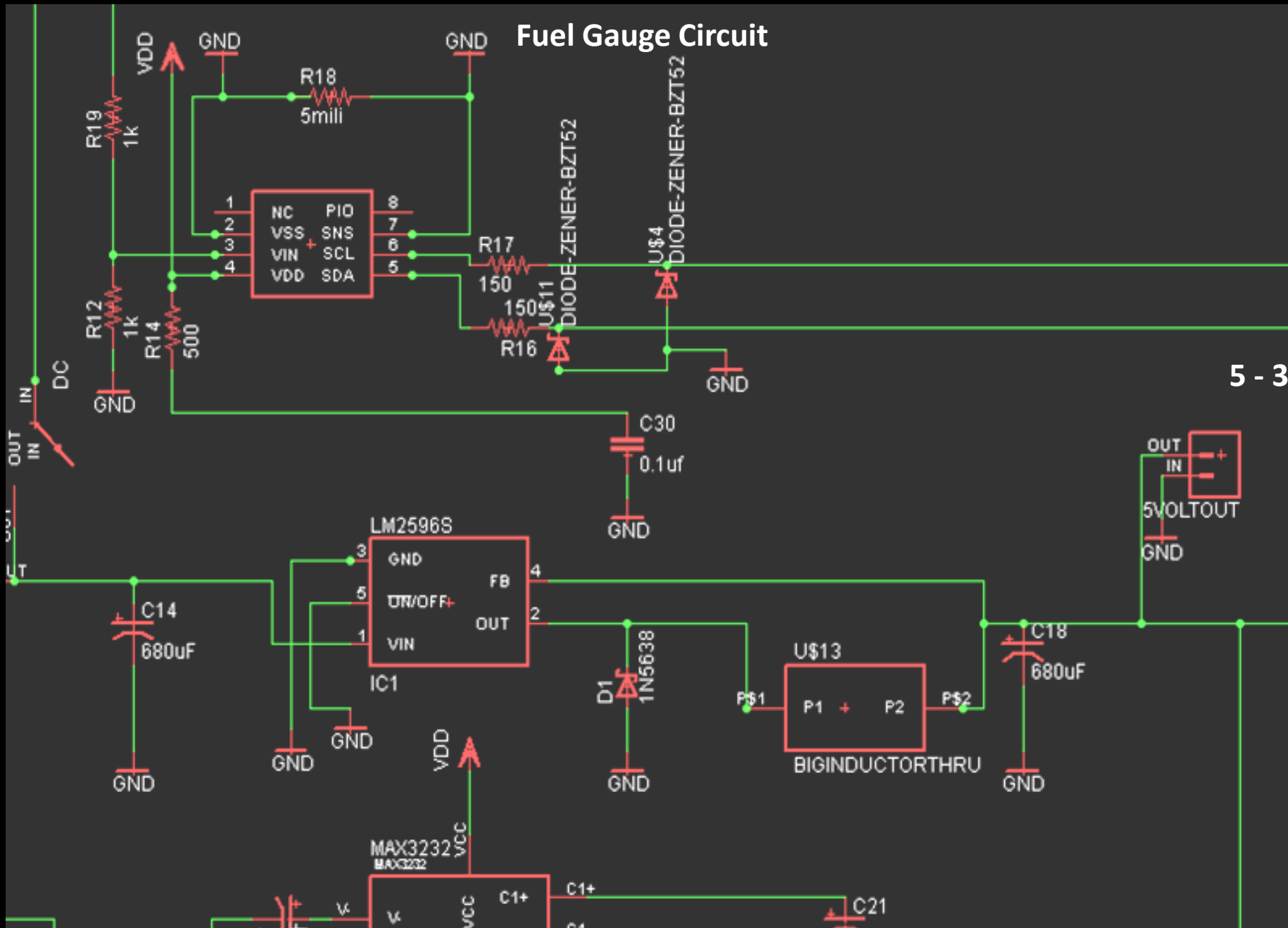
High/Medium Level Failures



High/Medium Level Failures

B-3	Battery charge level reported at levels inconsistent with actual levels	Fuel gauge IC failure or R18 short, R12/R19 short/open, microcontroller I^2C failure	Battery charge level reported at levels inconsistent with actual levels	Measure R18, R19, R12 values, test micro I^2C comm., test replace fuel gauge IC	Medium	This could indicate a fuel gauge failure that might result in attempts to overcharge the battery.

High/Medium Level Failures



Software Design / Development Status

Peripheral Name	Comm. Status	Algorithm	Algorithm Status
PC RS232 Comm.	1xUART **Tested OK**	Functions to send data packets and receive interrupt	**Implemented** **Tested OK**
GPS	1xUART **Tested OK**	Interpretation of packets received + config if necessary	**Unimplemented (medium priority)**
Accelerometer	3xADC **Tested OK**	Conversion of data into g-force measurements	**Implemented** **Tested OK**
Thermometer	1xADC **Untested**	Conversion of data into temperature measurement	**Unimplemented (low priority)**
Charge Counter	1xI^2C **Tested OK**	Configuration setup and interpretation of sent packets	**Implemented** **90% Complete**
Buttons	7xGPIO **1 Tested**	Sampling of buttons + assignment to actions	**1 Implemented** **Tested OK**
GUI elements on Atom	1xRS232 **Tested OK**	Display GUI, receive/interpret packets from PIC32	**In development** **~20% Complete**

Project Completion Timeline

Week #	Objectives and Milestones
Week 08	**Finish PCB adjustments pending Design Review & Course Staff feedback, prototype battery management circuitry, mockup helmet GUI – 100% complete**
Weeks 09-10	**Complete PCB Design & send for fabrication, begin intensive motherboard software development, backpack unit specification – 100% complete**
Week 11	**Receive PCB and begin population, procure backpack unit housing, further develop motherboard software and helmet GUI – 100% complete**
Week 12	PCB population should be nearly complete, Debug PCB, begin testing on a system level, begin software testing, begin 'companion application' development (for logged data)
Week 13	Debug software and hardware, continue system level testing, continue companion application development, GPS and thermometer algorithms
Week 14	Debug software and hardware, continue system level testing, continue companion application development
Week 15	Debug software and hardware, continue system level testing, continue companion application development
Week 16	Demonstrate PSSCs and submit final report and poster

Questions ?