# THE INCREDIBLE HUD


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# Outline

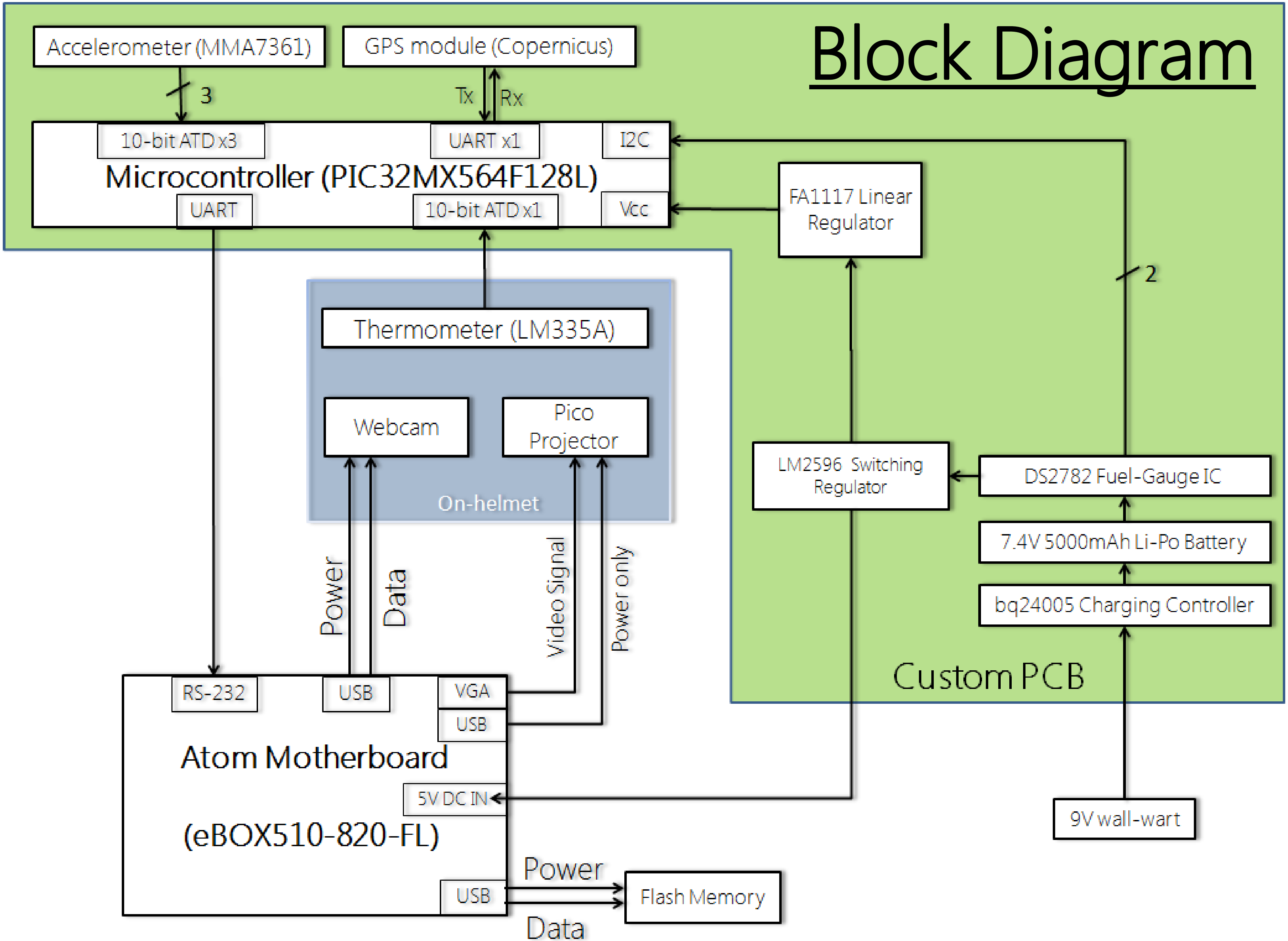
- Project overview
- Project-specific success criteria
- Block diagram
- Component selection rationale
- Packaging design
- Schematic and theory of operation
- PCB layout
- Software design/development status
- Project completion timeline
- Questions/Discussion

# 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 computer.


Block Diagram
Accelerometer (MMA7361)
3
GPS module (Copernicus)
Tx
Rx
10-bit ATD x3
UART x1
I2C
Microcontroller (PIC32MX564F128L)
UART
10-bit ATD x1
Vcc
FA1117 Linear Regulator
2
Thermometer (LM335A)
Webcam
Pico Projector
On-helmet
Power
Data
Video Signal
Power only
LM2596 Switching Regulator
DS2782 Fuel-Gauge IC
7.4V 5000mAh Li-Po Battery
bq24005 Charging Controller
Custom PCB
RS-232
USB
VGA
USB
Atom Motherboard
(eBOX510-820-FL)
5V DC IN
9V wall-wart
USB
Power
Data
Flash Memory

# Motherboard Selection Rationale

- Main design constraints :
  - Small size
  - Low power consumption
  - Video-processing capable (VGA output and web camera handling)
  - Robust packaging (case/shield)

- Chose Atom (eBOX510-820-FL)
  - Met constraints
  - Pulls 2W, 1.1 GHz clock, and supports UNIX and Windows Embedded 7 with great driver support
  - Other option was ARM Cortex A8 based Beagle Board
    - clocks 600 MHz and only supports UNIX with driver support not guaranteed
  - Has standard packaging solutions – no custom fabrication required
    - Case doubles as a heat sink

# Microcontroller Selection Rationale

- Worst-case analysis at start of project:
  - 12 ADC channels for peripherals
  - At least 2 and preferably 3 UARTs
  - 2 $I^2C$
  - Enough RAM for lots of buffers

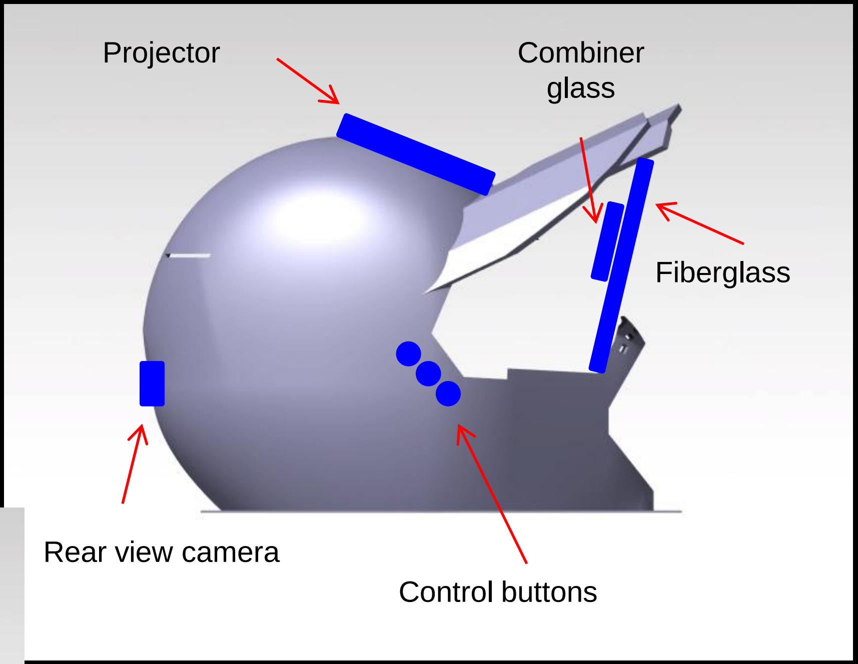
- Chose PIC32MX564F128L
  - Met all constraints plus ‘wiggle room’
  - Main contender was Atmel line of products
    - None met all of the desired constrains
  - Group experience with PICs, especially PIC32
  - Perfect micro (as of now) PIC24FJ64GA106

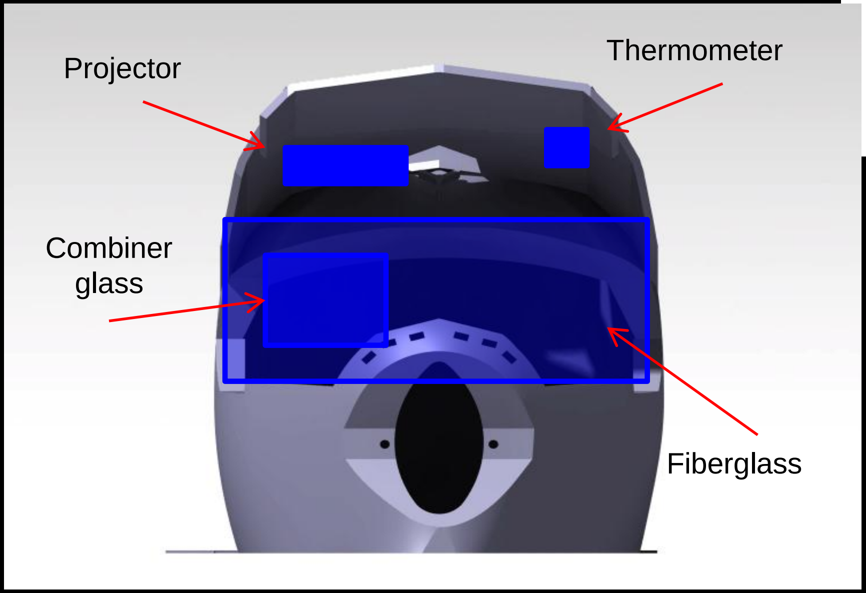
# Projector Selection Rationale

- Design considerations :
  - Small
  - Lightweight
  - USB powered
  - High resolution (WVGA)
  - Focused at infinity
- Chose Microvision SHOWX+ Laser pico-projector
  - Met considerations
  - Completely solid state
  - Competitor was Optoma PK201 LED pico-projector
    - Slightly brighter but also 40g heavier
    - LED projection technology requires manual focusing and has moving parts – less rugged

# Packaging Design: Helmet

- Helmet module:
  - Projector
  - Optic glass/lens
  - Fiberglass visor
  - Thermometer
  - Rear view camera
  - Control buttons

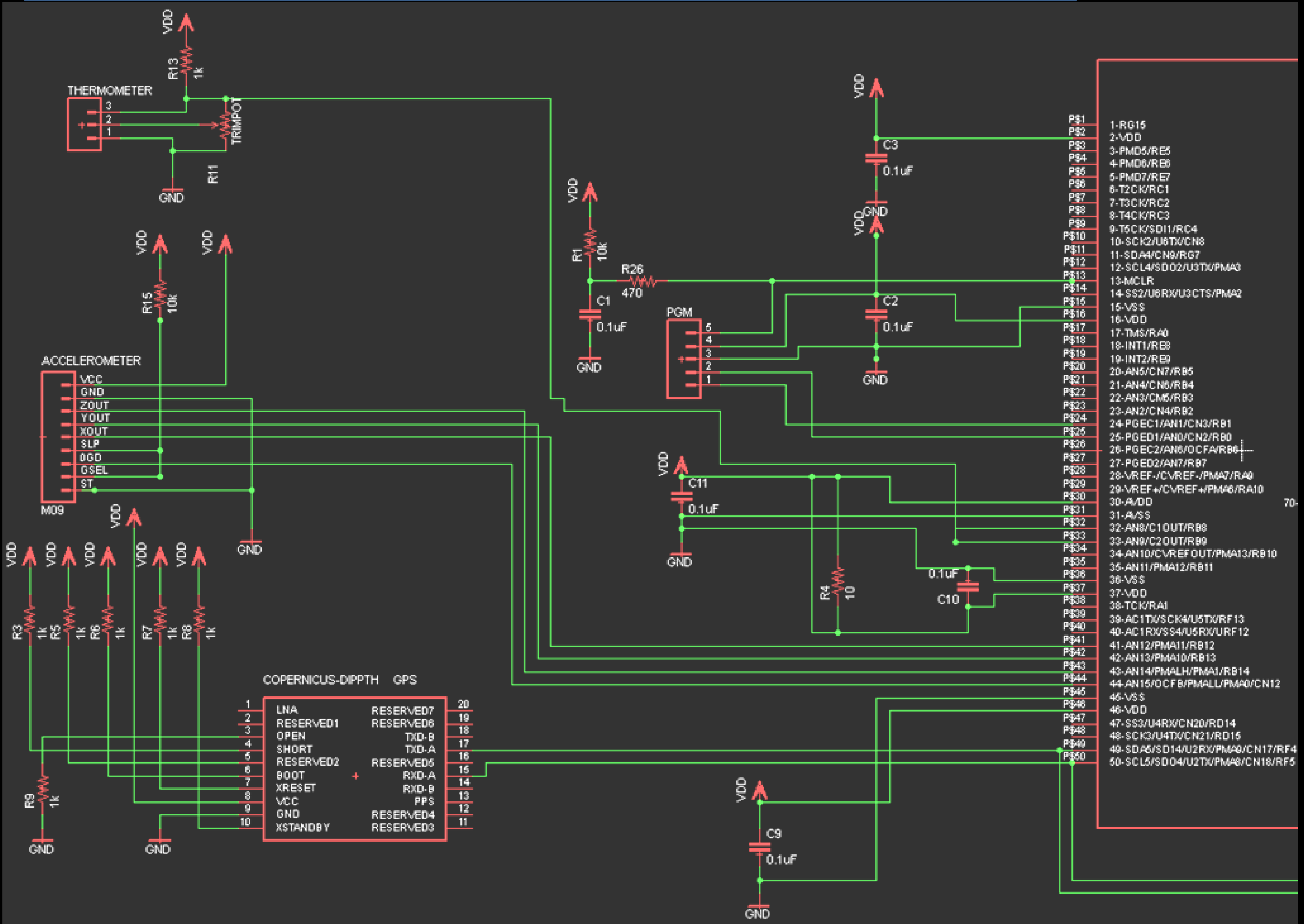


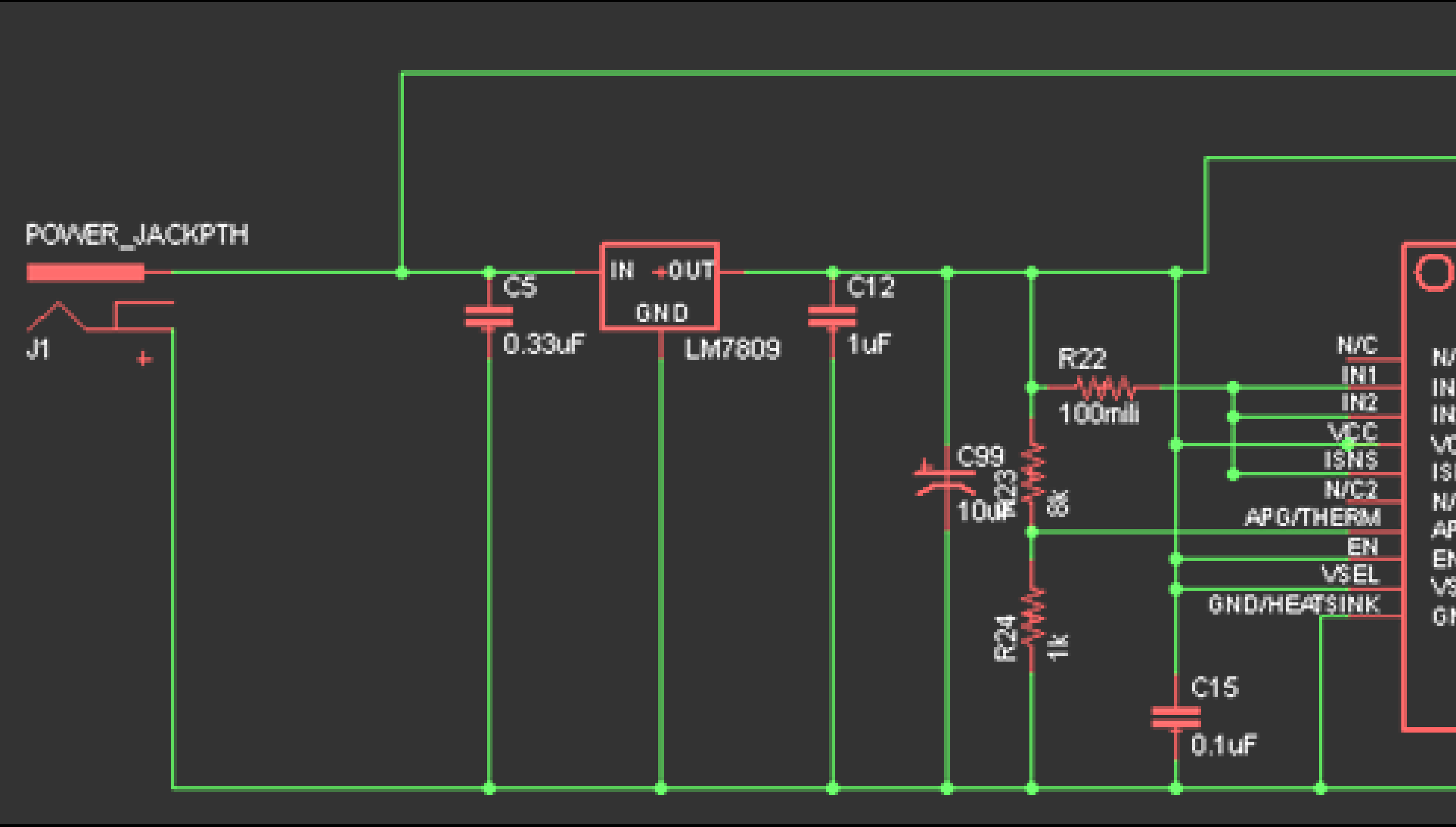
# Packaging Design: Backpack

- Backpack module:
  - Motherboard
  - PCB
  - Battery
  - Cooling fans
- Promotes mobility and portability
- Robust for weather and impact resistance
- Streamlined

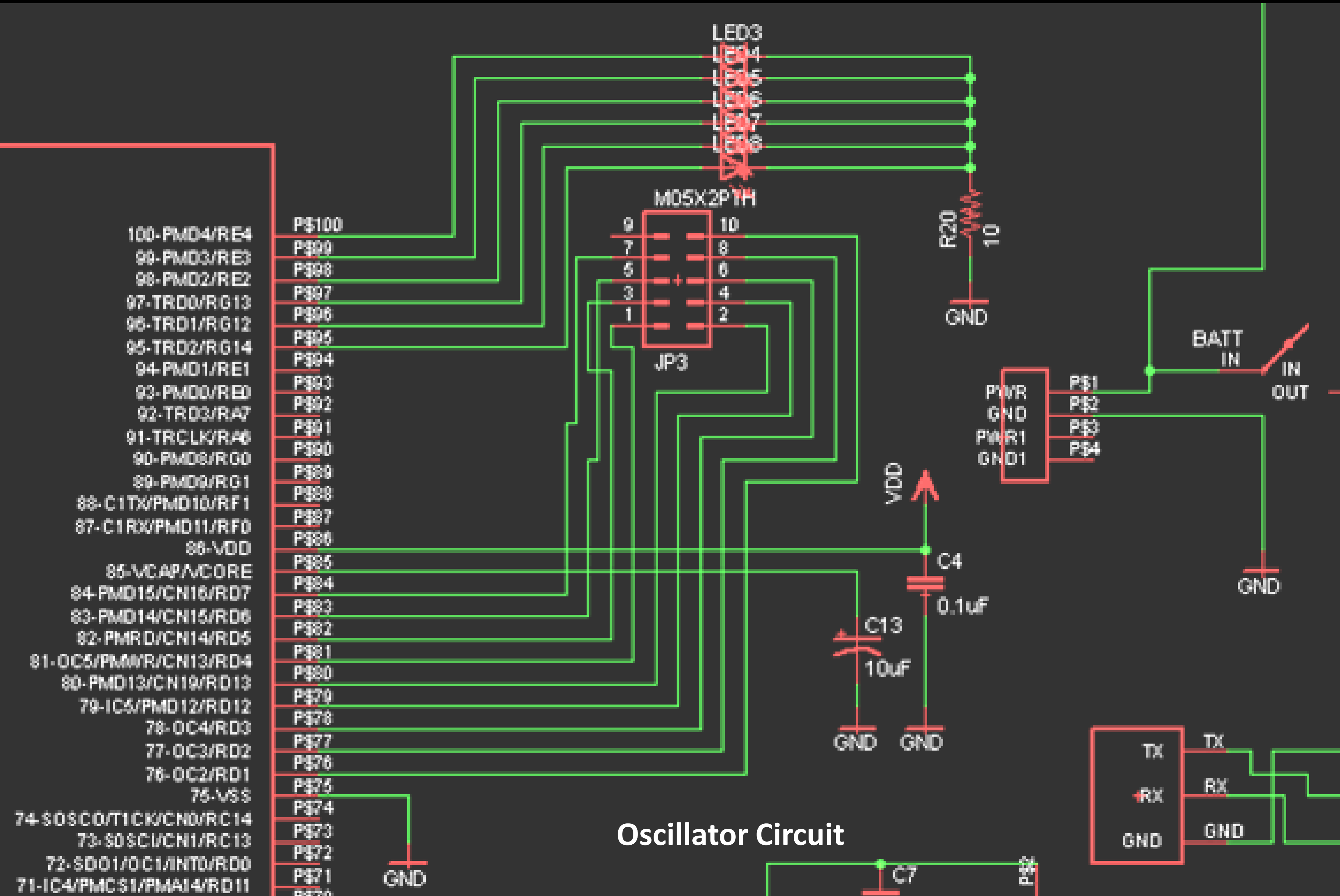
# Schematic/Theory of Operation: Peripherals and Microcontroller



# Schematic/Theory of Operation: Battery Charging Circuit

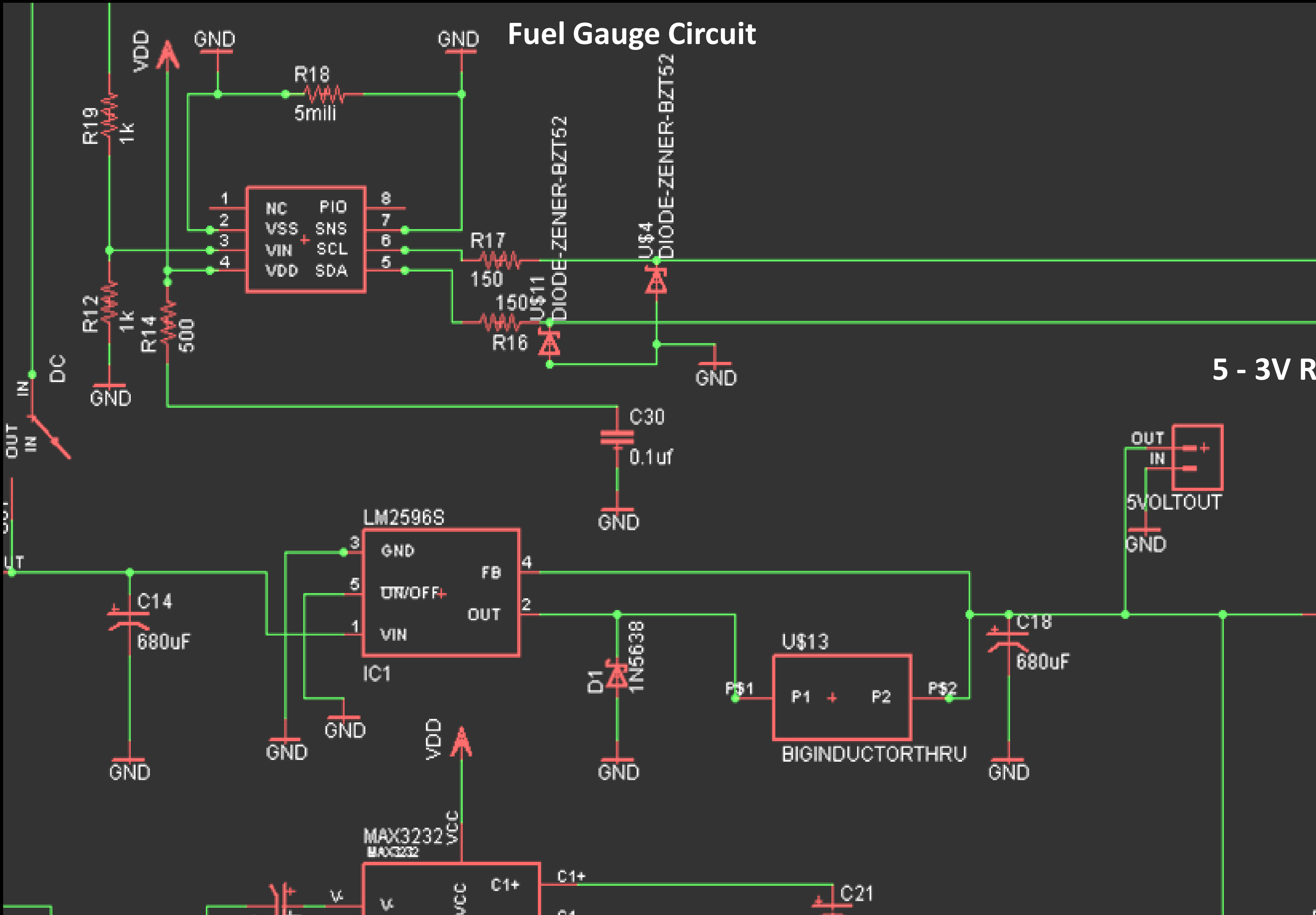


# Schematic/Theory of Operation: Peripherals and Interfacing

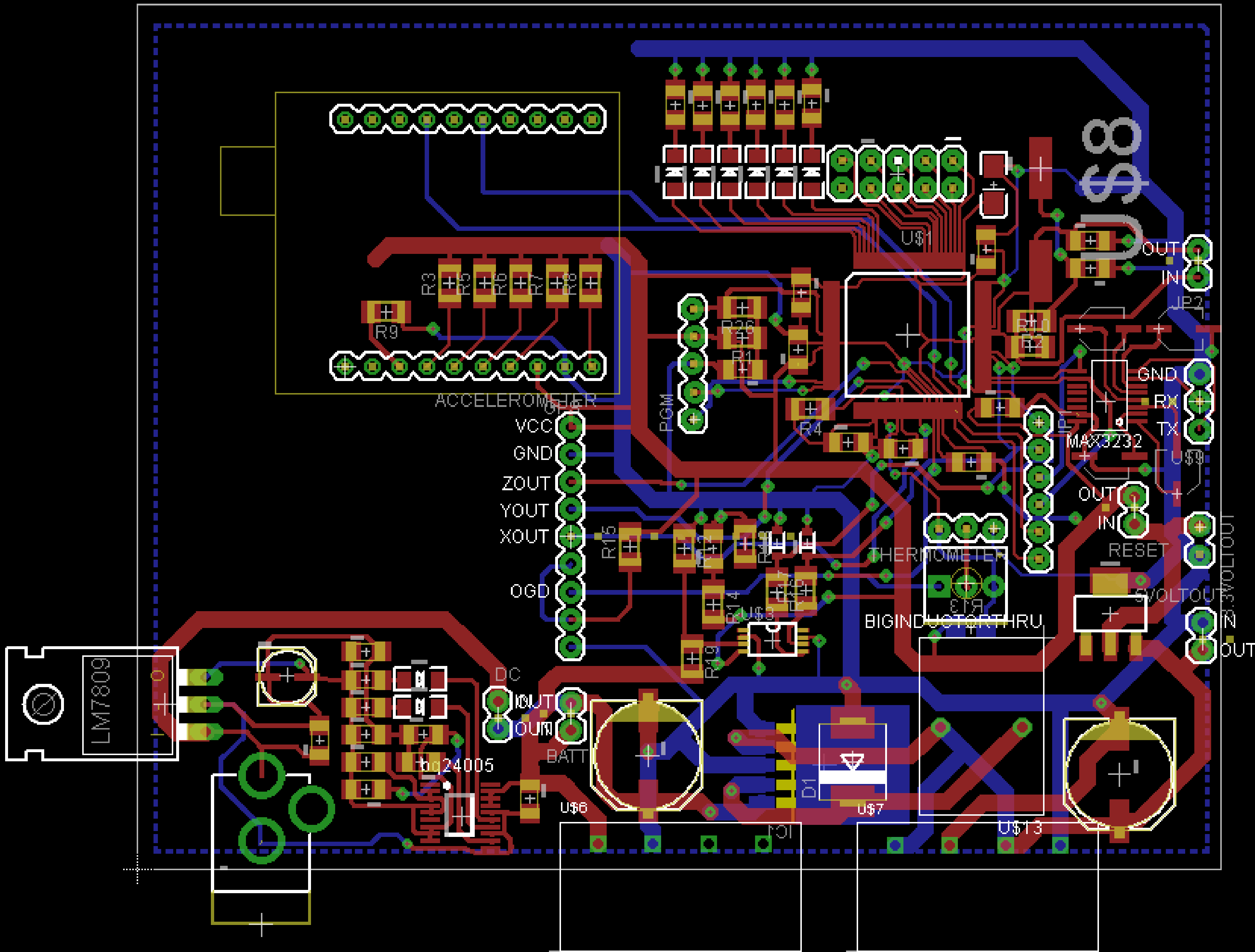



Oscillator Circuit

# Schematic/Theory of Operation: Fuel Gauge and Voltage Regulator

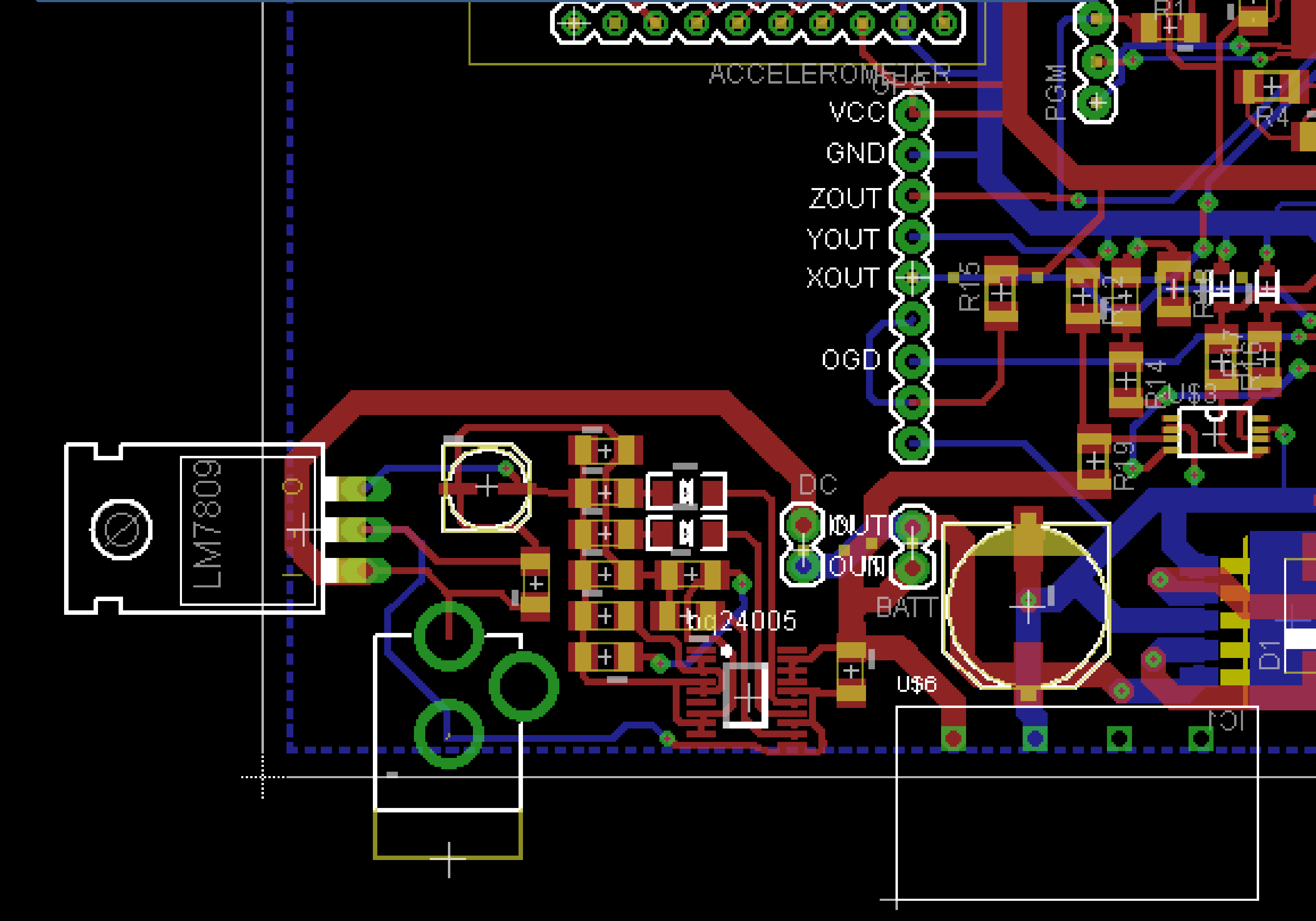


# PCB Layout



ACCELEROMETER
VCC
GND
ZOUT
YOUT
XOUT
OGD
THERMOMETER
BIGINDUCTORTHRU
MAX3232
GND
RX
TX
OUT
IN
RESET
5VOLTOUT
3.3VOLTOUT
LM7809
bq24005
DC
BATT
PGM
U$1
U$6
U$7
U$13
D1

# PCB Layout


ACCELEROMETER
VCC
GND
ZOUT
YOUT
XOUT
OGD
PGM
LM7809
DC
BATT
bq24005
U$6
U$3
R26
R1
R4
R15
R12
R14
R19
D1
IC1

# Software Design / Development Status

| Peripheral Name | Comm. Status | Algorithm | Algorithm Status |
|---|---|---|---|
| PC RS232 Comm. | 1xUART<br>Tested OK | Functions to send data packets and receive interrupt | Implemented<br>Tested OK |
| GPS | 1xUART<br>Tested OK | Interpretation of packets received + config if necessary | Unimplemented |
| Accelerometer | 3xADC<br>Tested OK | Conversion of data into g-force measurements | Implemented<br>Tested OK |
| Thermometer | 1xADC<br>Untested | Conversion of data into temperature measurement | Unimplemented |
| Charge Counter | 1x$I^2C$<br>Untested | Configuration setup and interpretation of sent packets | Unimplemented<br>(#1 PRIORITY) |
| Buttons | 7xGPIO<br>1 Tested | Sampling of buttons + assignment to actions | 1 Implemented<br>Tested OK |
| GUI elements on Atom | 1xRS232<br>Untested | Display GUI, receive/interpret packets from PIC32 | Unimplemented |

# 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 |
| Week 09 | Complete PCB Design & send for fabrication, begin intensive motherboard software development, backpack unit specification |
| Week 10 | Receive PCB and begin population, procure backpack unit housing, further develop motherboard software and helmet GUI |
| Week 11 | Debug PCB, begin testing on a system level, begin software testing, begin ‘companion application’ development (for logged data) |
| Week 12 | Debug software and hardware, continue system level testing, continue companion application development |
| Week 13 | Debug software and hardware, continue system level testing, continue companion application development |
| 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 ?