Calibration

Calibration of sensors (pack and AMS sensors) is done by adjusting the values in params.h in source code.

Slope and offset values are used in all cases. Sensors should be calibrated in the test stand with lab power supplies providing power. To calibrate a sensor, its slope cal factor should be set to 1.0 and offset to 0.0. Output on the LCD screen will then be the raw sensor value. Data points at the high and low end of a sensor should be taken and compared with values measured with a calibrated device to calculate slopes and offsets.

Data collected for calibration (and the calculations of cal factors) can be found in xlsx format at the following address:

https://sites.lafayette.edu/ece492-sp16/files/2016/05/CalData.xlsx

State Transition Diagram
PacMan Software

The current version of PacMan software is v 0.14 and source code is available at the following address:

https://sites.lafayette.edu/ece492-sp16/files/2016/05/pacman_software_v0_14.zip

The tool chain is unchanged from previous versions of PacMan and details about it are available at the following address:


The software is built on the Atom Threads RTOS. Atmel TWI and CAN libraries are utilized to achieve communication. All configurations (I2C addresses, CAN addresses, calibration factors) are stored in params.h

The code in main.c sets up tasks listed in tasklist.c and starts the RTOS. Functions that generate LCD screens are detailed in lcd.c. Functions that utilize TWI libraries to perform I2C communication are detailed in i2c.c. The remaining c files detail tasks that run continuously:

- task_button.c - retrieves button presses on the control panel
- task_can.c - transmits CAN messages
- task_charge.c - performs integration of current and calculates state of charge
- task_config.c - performs state transitions
- task_gui.c - calls function in lcd.c to set the display output
- task_heartbeat.c - blinks an LED on PacMan to indicate the computer is operating
- task_i2c.c - calls functions to perform I2C communication tasks
- task_safety.c - opens and closes the safety loop relay
- task_watchdog.c - resets off chip watchdog

Schematics

PacMan

Attached are schematics generated from KiCad. The KiCad project is available at the following address:

https://sites.lafayette.edu/ece492-sp16/files/2016/05/pacman_hardware_rev_0_5.zip
Accumulator

Attached are schematics generated from KiCad. The KiCad project is available at the following address:

https://sites.lafayette.edu/ece492-sp16/files/2016/05/accumulator.zip

Bill of Materials

PacMan

A csv BOM generated from KiCad is available at the following address:

https://sites.lafayette.edu/ece492-sp16/files/2016/05/pacman-main.csv

Accumulator

A csv BOM generated from KiCad is available at the following address:

https://sites.lafayette.edu/ece492-sp16/files/2016/05/accumulator.csv
**POWER ELECTRONICS**

**DC-DC Switching Power Regulation**
5V and 3.3V outputs are isolated from High Voltage, but not each other

Isolated Power Supply

**FTDI USB UART**

FTDI USB UART

**SAFETY LOOP WIRING**

Safety Loop Wiring

**CAN TRANCEIVER**

CAN Transceiver

**CONNECTORS**

External Connectors

---

**AVR MICROCONTROLLER**

AVR Decoupling Capacitors (U1)

---

**GROUND LOW VOLTAGE**

+3.3V

---

**SYSTEM STATUS LEDS**

- **GREEN 01**
- **RED 02**
- **GREEN 03**

---

**EXTERNAL WATCHDOG**

- **RST**
- **VCC**
- **GND**
- **+3.3V**

---

**DEVELOPMENT ONLY**

Engineer: Geoff Nudge
Supervisor: Christopher Nadovich
Spring Semester 2015
Lafayette College

Sheet: /pacman-main.sch

Title: Battery Pack Management Computer

Size: USLetter  Date: 2016-04-01  Rev: 0.5
KiCad E.D.A.  kicad 4.0.2-4+622538ubuntu14.04.1-stable  Id: 1/6
HIGH VOLTAGE INTERFACES

HIGH VOLTAGE POWER

This power supply is responsible for delivering non-isolated 5V power to the high voltage electronics. All AMS bus connected devices are powered from this regulator. Maximum current draw is 250mA. This Switcher was selected for its high efficiency even at light load.

Maximum Current Draw on 5V output: 1.2A

HIGH VOLTAGE DIGITAL I/O

This I/O expander is responsible for relaying digital signals across the HV-LV isolation barrier via the I2C bus.

I2C PULLUP

I2C ISOLATOR

HIGH VOLTAGE ISOLATOR

The flyback regulator responsible for delivering 5V isolated power to low voltage systems has been replaced with an isolated DC/DC converter. This is due to the insufficient output current (300mA) available when assembled. Cost is comparable.

Low Voltage

3.3V Linear Regulator

Maximum Current Draw on 5V output: 1.2A

DEVELOPMENT ONLY

Engineer: Geoff Nudge
Supervisor: Christopher Nadovich
Fall Semester 2015
Lafayette College
Sheet: Isolated Power Supply/
File: power.sch

Title: Battery Pack Management Computer
Size: USLetter Date: 2016-04-01 Rev: 0.5
KiCad E.D.A. KiCad 4.0.2-4+622538ubuntu14.04.1-stable Id: 2/6
SAFETY LOOP RELAY

This relay is responsible for switching the PACMAN safety loop connection ON/OFF. The lights show the user at a glance if the safety loop is open or closed.

This relay is capable of switching 8A. The SLOOP_CTRL signal is active low.

SAFETY LOOP RELAY

- A1 and B1 pins are shorted together only when the safety loop is not opened by this board.
- Voltage between A3 and A4 greater than 0 means the safety loop is not opened by any other component in the system.

FAN CONTROL P-FET

This MOSFET is responsible for switching the charge fan ON/OFF. The fan will not come on automatically when charging begins. It is controlled by the software.

FAN CONTROL P-FET

- Coil Output Voltage: 5V

GROUNDED LOW VOLTAGE

- +3.3V
- +5V
- GND

DEVELOPMENT ONLY

Title: Battery Pack Management Computer

Size: USLetter  Date: 2016-04-01  Rev: 0.5

KCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable  Id: 3/6
NOTE: DO NOT populate R26. R26 provides the ability to use this board as a terminating CAN node in development only.
USB BOOTSTRAP POWER

This diode is used to power the PACMAN computer board when the battery pack has been fully discharged. If voltage is not present between PACK+ and PACK-, then this diode will allow the USB port to supply up to 500mA of sustained current. For periods less than 0.1 seconds, 1A can be drawn.

VUSB

USB UART

This is an FTDI USB Serial Converter IC. It can be used to upload code, configure the device, or transfer debugging information if the software is configured properly.

Drivers available for Windows, Mac OS & Linux

DEVELOPMENT ONLY
Engineer: Geoff Nudge
Supervisor: Christopher Nadovich
Fall Semester 2015
Lafayette College
Sheet: /FTDI USB UART/
File: ftdi_uart.sch

Title: Battery Pack Management Computer
Size: US Letter Date: 2016-04-01 Rev: 0.5
KCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable Id: 5/6
### HIGH VOLTAGE

- **POWER**
  - 1: GND
  - 2: VUSB
  - 3: Vbus
  - 4: D-
  - 5: D+
  - 6: GND

A jumper in the Anderson charge connector pulls an input low on the HV I2C expander, corresponding to either charge or low current output.

### USB UART

- **USB**
  - **GND**
  - **VUSB**

### PACK WIRING HARNESS APPLICATION NOTE

- **EXT I2C**
  - **GND**
  - **+5V**

This connector contains pins for I2C communication with the LCD screen, input from control panel push buttons, and to illuminate the pack一律 LED. If, at a later time, more complicated LCDs, or more I/O is required these pins can be utilized.

### GPIO HEADER

- **0.1" IDC Connector**

- **External User Interface Board**

### SAFETY LOOP A/B

- **SLOOP_A1**
- **SLOOP_B1**
- **SLOOP_A2**
- **SLOOP_B2**
- **SLOOP_A3**
- **SLOOP_A4**
- **SLOOP_B3**
- **SLOOP_B4**

Pins in these sections are connected to obsolete signals in the test stand. They may be used, but the test stand must be updated as well.

### GLV HARNESS

- **CDETECT**

This R/J (RJ12 with center four pins utilized) connects allows the BBM-04 current sensor to connect to the board.

### AVR DEBUGGING

- **JTAG Programming/Debug Header**

### DEVELOPMENT ONLY

- **Title:** Battery Pack Management Computer
- **Engineer:** Geoff Nudge
- **Supervisor:** Christopher Nadovich
- **Spring Semester 2016
- Lafayette College
- Sheet: /External Connectors/
- File: connectors.sch
NOTES

1) Fuse holder wires are fitted with crimp connector rings (left).
2) 00 AWG Positive cable is fitted with crimp connector (right).
3) 00 AWG Positive cable is fitted with crimp connector (right).
4) An additional relay and splice on safety loop wires are req’d on
   1 of the 4 accumulators in a vehicle. It is located between
   CELL1- and the 200 A fuse.
5) Anderson Power connectors require each 1 black 4827 housing.
   The snap in recepticle also requires 1 black 4827 housing.
6) Blue italic numbers are the wire labels applied in an accumulator.
SEE MECHANICAL DRAWINGS FOR DETAILS OF ALUMINUM BARS USED TO CONNECT CELLS