

Appendix A:

Schematics

ECE 492 - Spring 2016

[Full System Schematic](#)

[GLV Power/SCADA/Safety](#)

[TSIHV](#)

[TSILV](#)

[Accumulator](#)

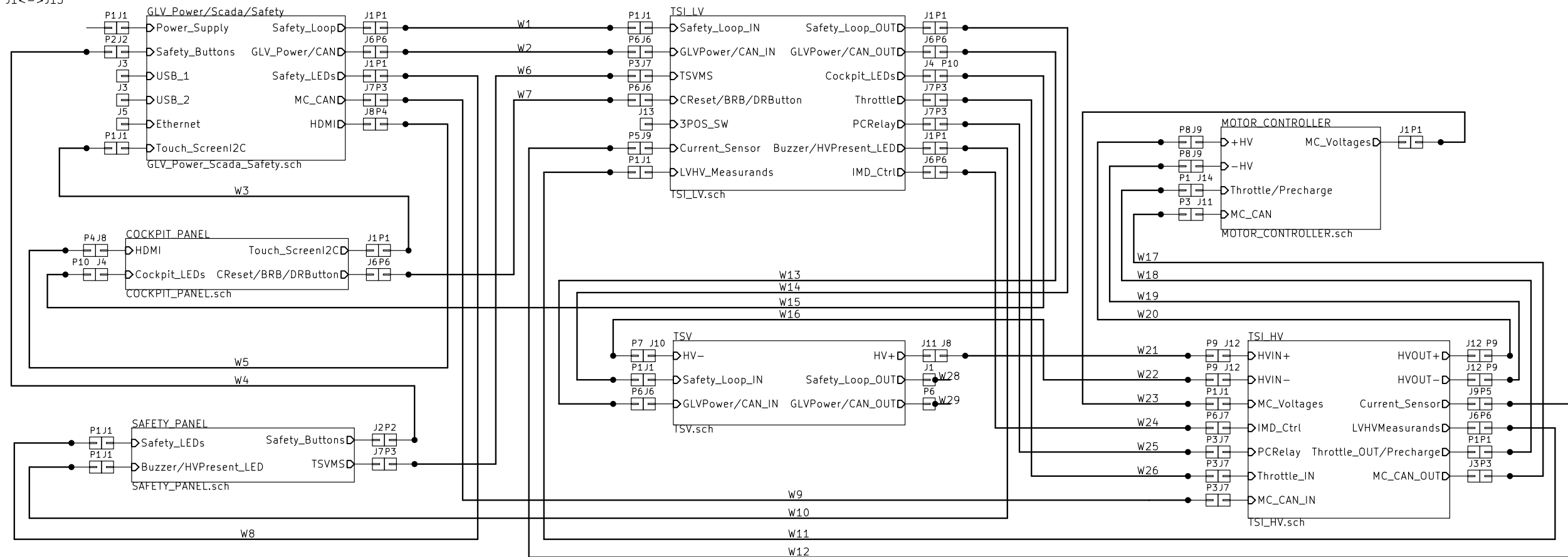
[Accumulator Wiring Diagram](#)

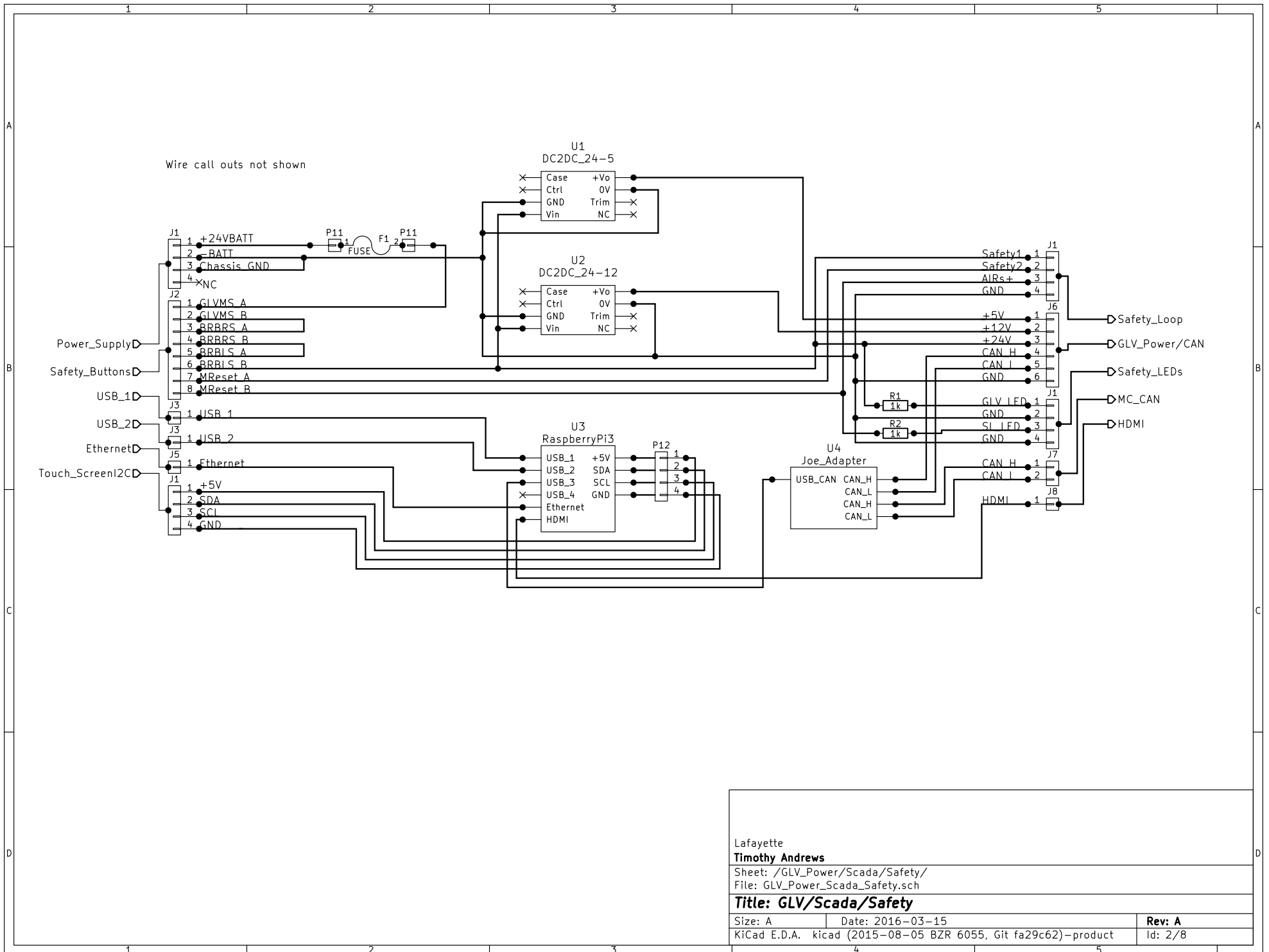
[PacMan Schematic](#)

[Control Panel Schematic](#)

This document includes the following plugs, jacks and wires:

W1<->W29
P1<->P10
J1<->J13





Lafayette

Timothy Andrews

Sheet: /GLV_Power/Scada/Safety/

File: GLV_Power_Scada_Safety.sch

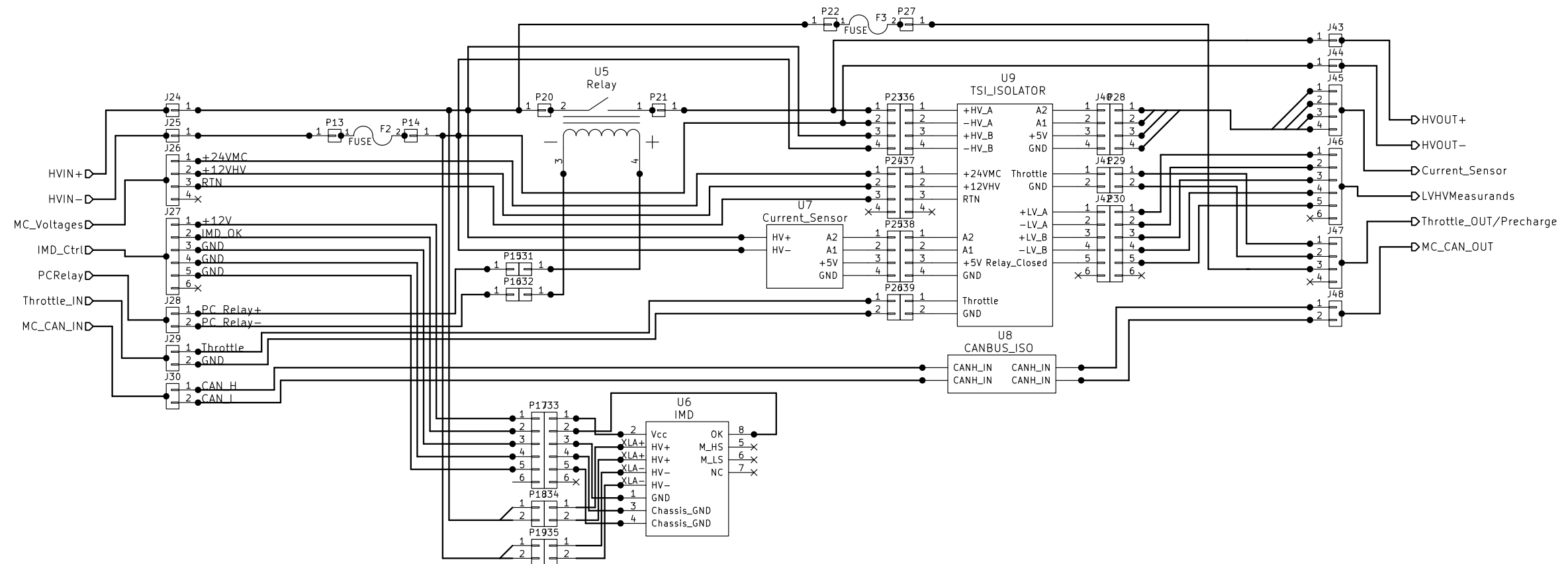
Title: GLV/Scada/Safety

Size: A Date: 2016-03-15

KiCad E.D.A. kicad (2015-08-05 BZR 6055, Git fa29c62)-product

Rev: A

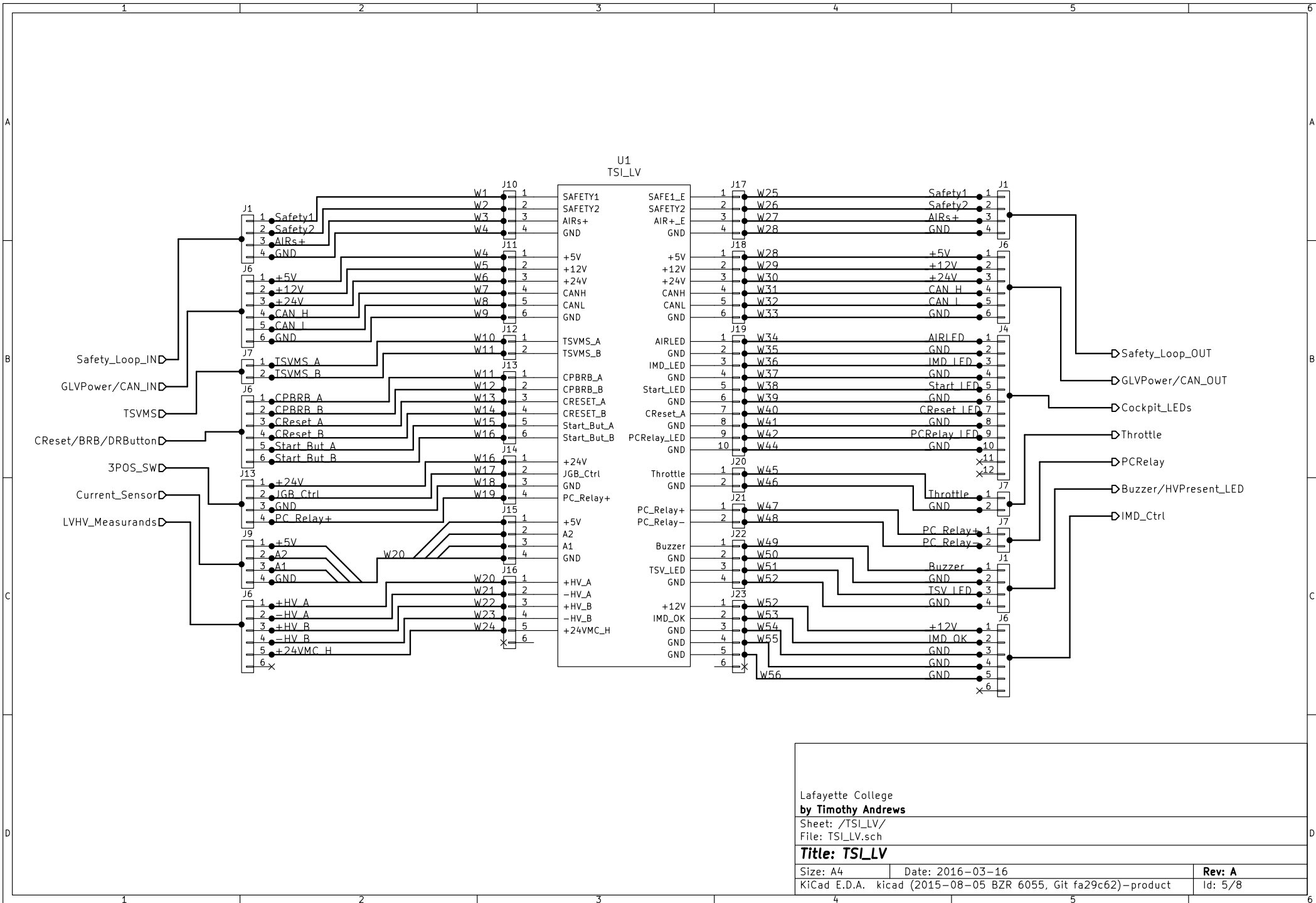
Id: 2/8



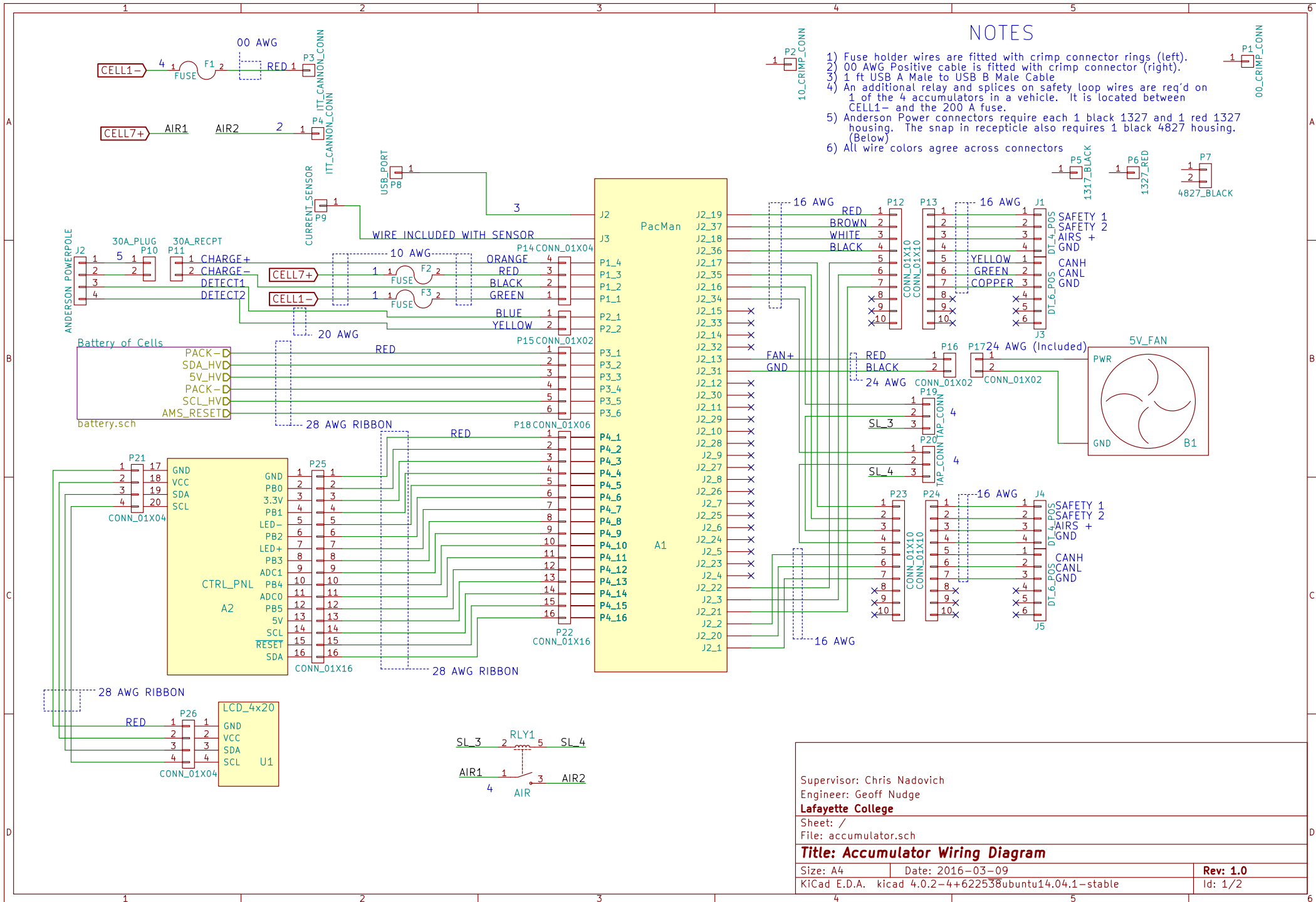
Lafayette College
 by Timothy Andrews
 Sheet: /TSL_HV/
 File: TSL_HV.sch

Title: TSL_HV

Size: B	Date: 2016-03-16	Rev: A
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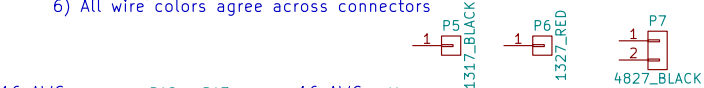


Lafayette College by Timothy Andrews	
Sheet: /TSI_LV/ File: TSI_LV.sch	
Title: TSI_LV	
Size: A4	Date: 2016-03-16
KiCad E.D.A. kicad (2015-08-05 BZR 6055, Git fa29c62)-product	Rev: A Id: 5/8



NOTES

- 1) Fuse holder wires are fitted with crimp connector rings (left).
- 2) 00 AWG Positive cable is fitted with crimp connector (right).
- 3) 1 ft USB A Male to USB B Male Cable
- 4) An additional relay and splices 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 1327 and 1 red 1327 housing. The snap in receptacle also requires 1 black 4827 housing. (Below)
- 6) All wire colors agree across connectors



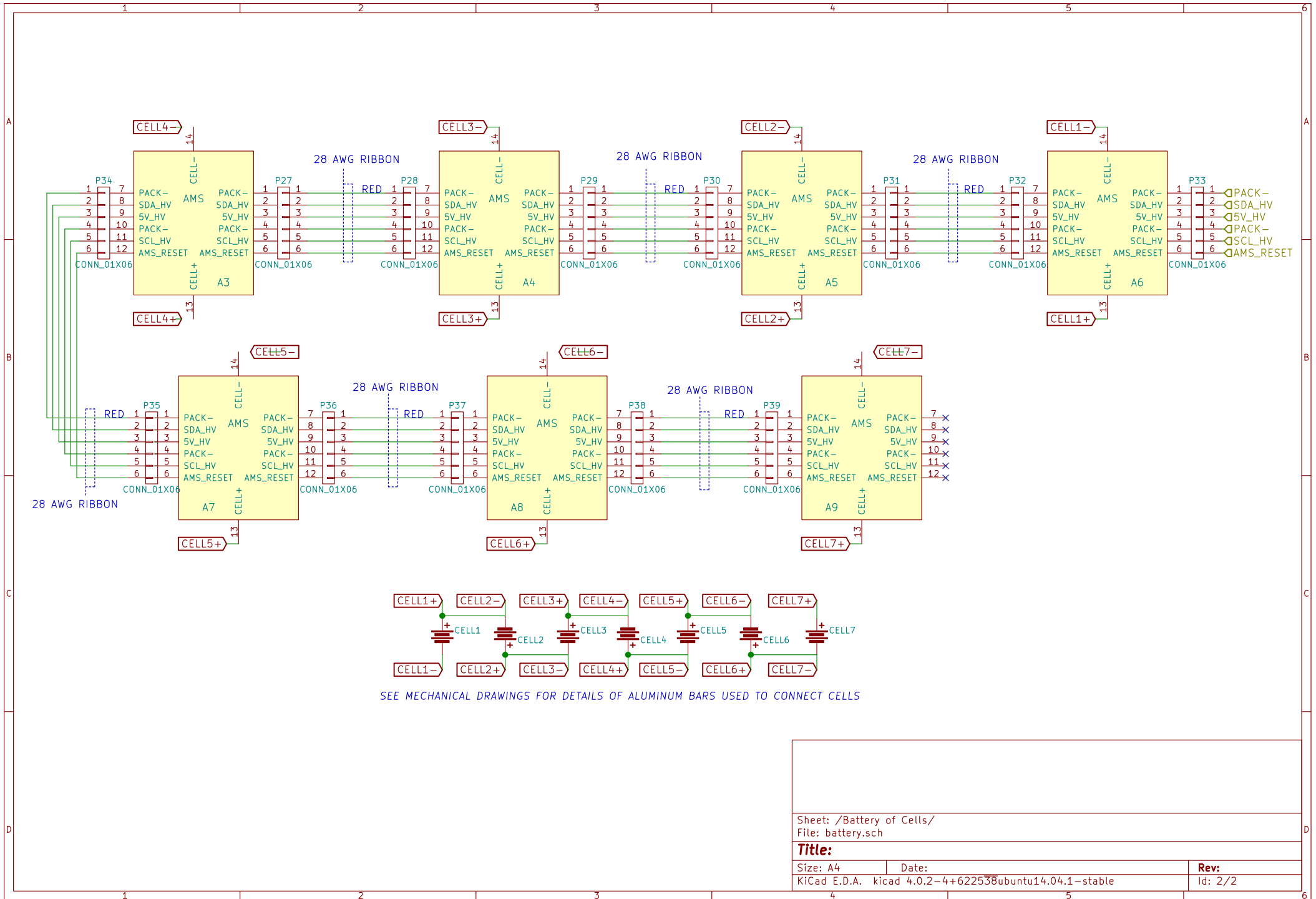
Supervisor: Chris Nadovich
 Engineer: Geoff Nudge
Lafayette College

Sheet: /
 File: accumulator.sch

Title: Accumulator Wiring Diagram

Size: A4 Date: 2016-03-09
 KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable

Rev: 1.0
 Id: 1/2



Sheet: /Battery of Cells/
File: battery.sch

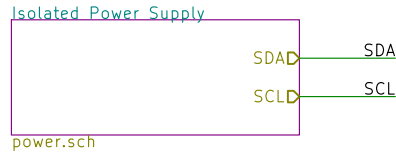
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KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable

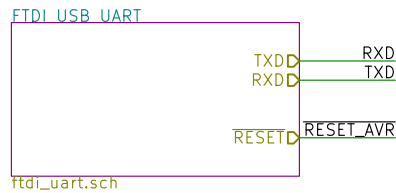
Rev:
Id: 2/2

POWER ELECTRONICS

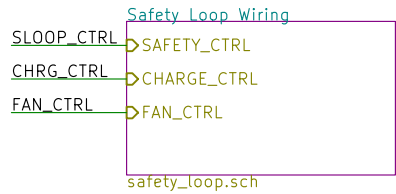
****DC-DC Switching Power Regulation****
5V and 3.3V outputs are isolated from High Voltage, but not each other



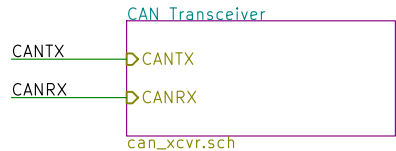
FTDI USB UART



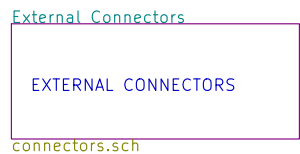
SAFETY LOOP WIRING



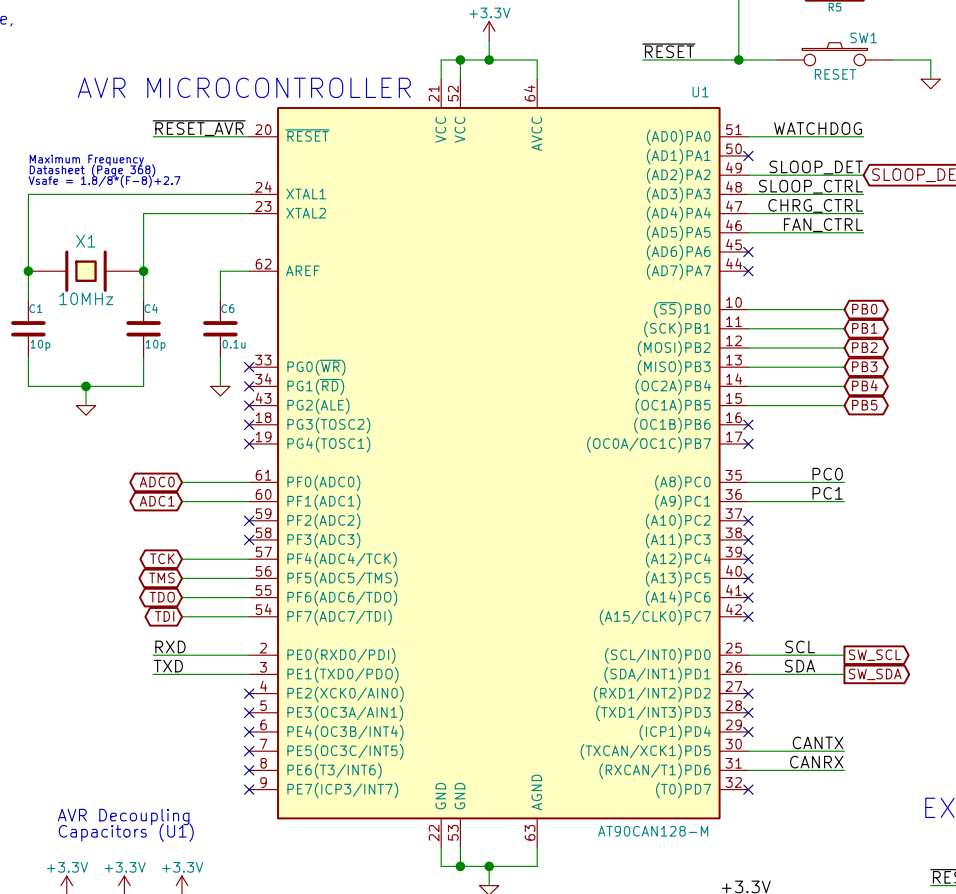
CAN TRANCEIVER



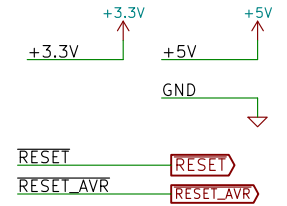
CONNECTORS



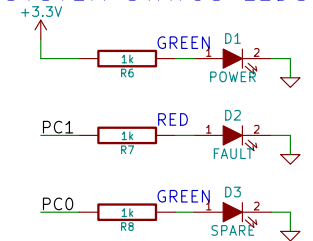
AVR MICROCONTROLLER



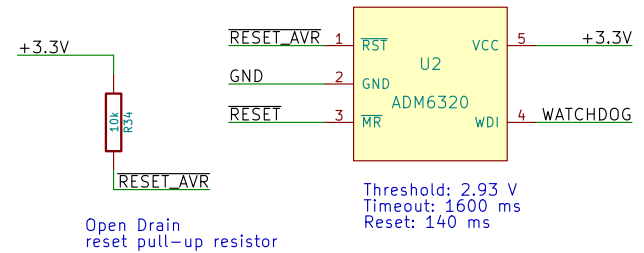
GROUNDED LOW VOLTAGE



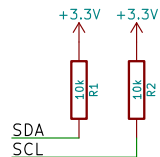
SYSTEM STATUS LEDs



EXTERNAL WATCHDOG

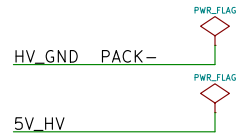
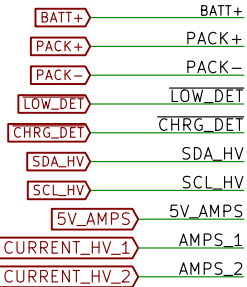


I2C PULLUP

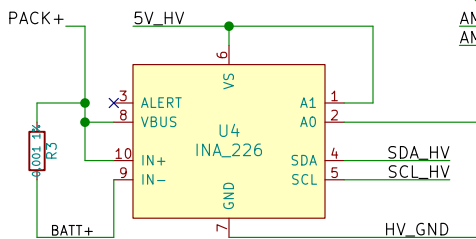


DEVELOPMENT ONLY	
Engineer: Geoff Nudge	
Supervisor: Christopher Nadovich	
Fall Semester 2015	
Lafayette College	
Sheet: /	
File: pacman-main.sch	
Title: Battery Pack Management Computer	
Size: USLetter	Date: Tue 6 Oct 2015
KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable	Rev: 0.4
	Id: 1/6

HIGH VOLTAGE INTERFACES



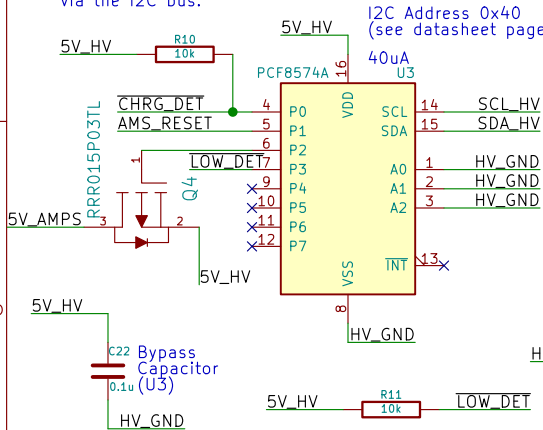
PACK VOLTAGE SENSOR AND CHARGE SENSOR



I2C Address 0x44
(see datasheet page 18)
Additional documentation
of the use of this component
is req'd.

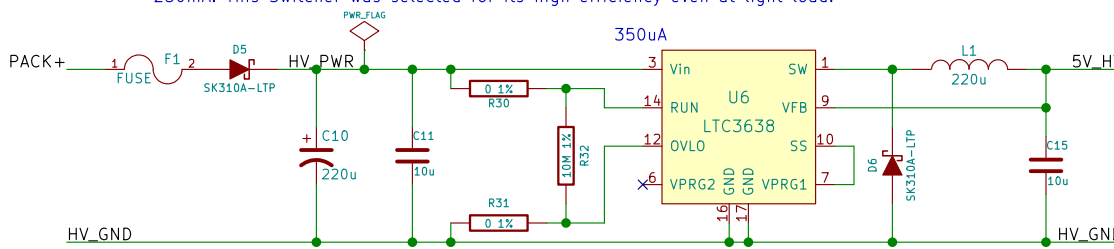
HIGH VOLTAGE DIGITAL I/O

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



HIGH VOLTAGE POWER

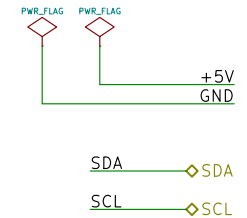
This power supply is responsible for delivering non-isolated 5V
power to the high voltage electronics. All AMS bus connected
devices are powered from this regulator. Maximum current draw
250mA. This Switcher was selected for its high efficiency even at light load.



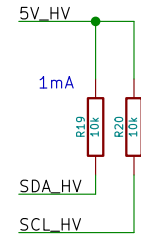
HIGH VOLTAGE



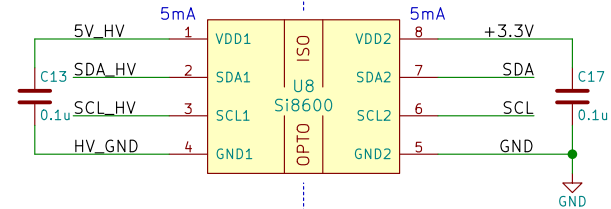
LOW VOLTAGE



I2C PULLUP

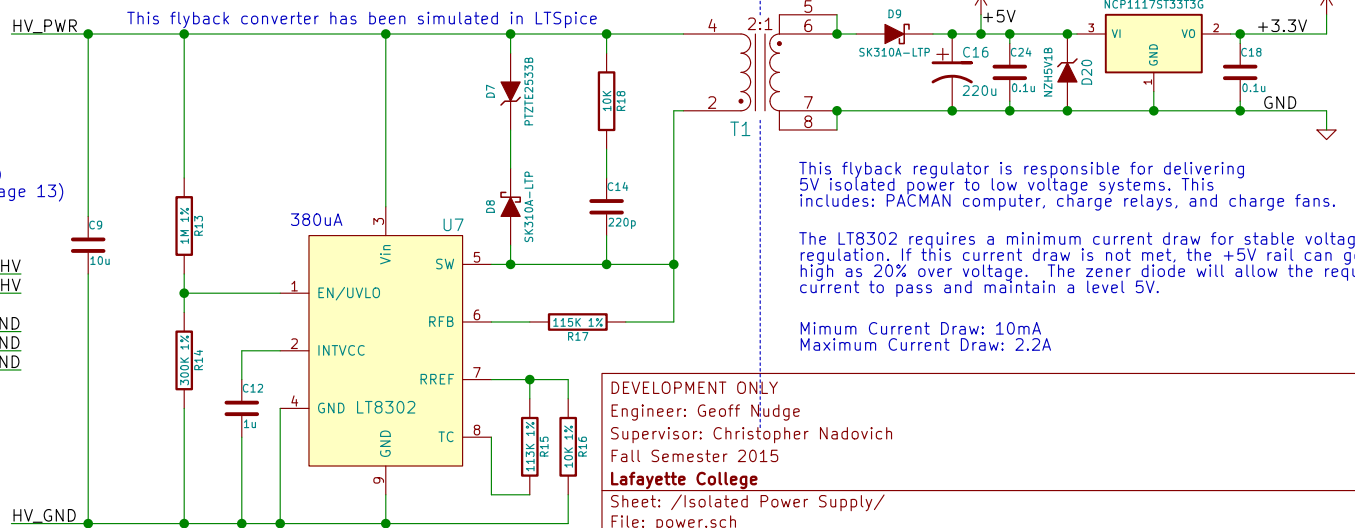


I2C ISOLATOR



HIGH VOLTAGE LOW VOLTAGE

WURTH_750311564



This flyback regulator is responsible for delivering
5V isolated power to low voltage systems. This
includes: PACMAN computer, charge relays, and charge fans.

The LT8302 requires a minimum current draw for stable voltage
regulation. If this current draw is not met, the +5V rail can go as
high as 20% over voltage. The zener diode will allow the required
current to pass and maintain a level 5V.

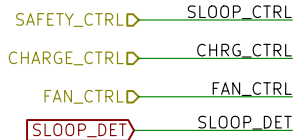
Minimum Current Draw: 10mA
Maximum Current Draw: 2.2A

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

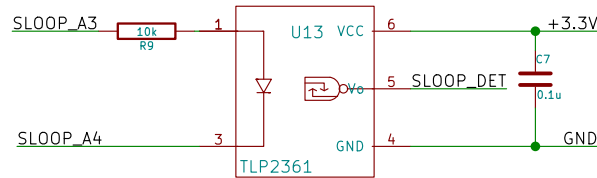
Size: USLetter Date: Tue 6 Oct 2015
KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable

Rev: 0.4
Id: 2/6



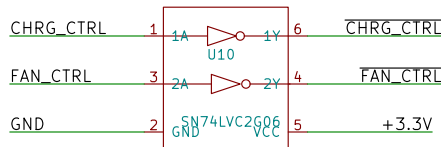
OPTO-ISOLATOR ON SL CLOSED SIGNAL

This device provides a galvanically isolated signal to the microcontroller to let it know the safety loop is closed in all components. The HV current sensor is enabled as a result. This means the AIRs should be closed if functional.



HIGH SIDE P-FET DRIVER

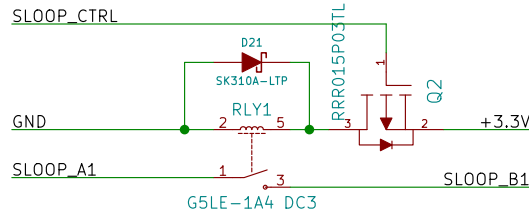
This device is responsible for driving the high side p-fet switches.



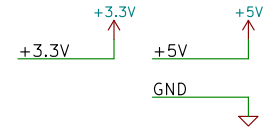
SAFETY LOOP RELAY

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.

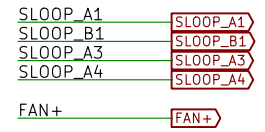
This relay is capable of switching 8A. The SLOOP_CTRL signal is active low.



GROUNDING LOW VOLTAGE



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.

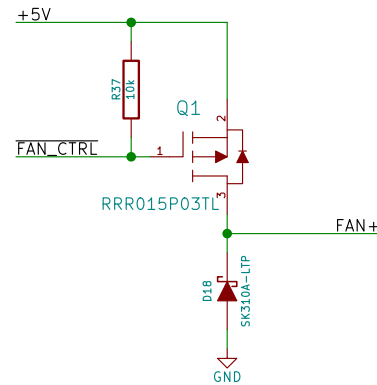


FAN CONTROL P-FET

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.

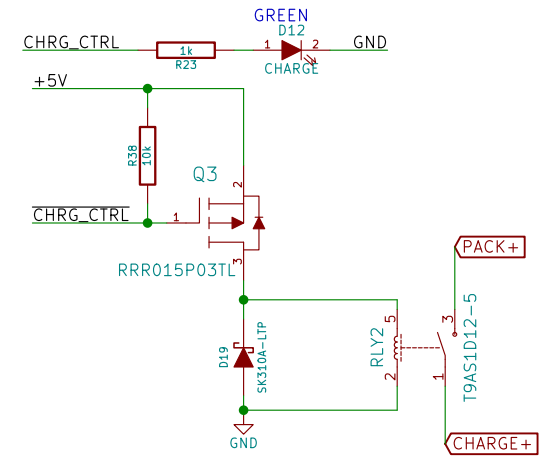
Fan Output Voltage: 5V



CHARGE CONTROL P-FET

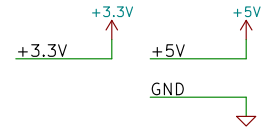
This MOSFET is responsible for connecting the CHARGE relays when the pack charger has been connected. Power is supplied from either the pack terminals, or USB connector.

Coil Output Voltage: 5V



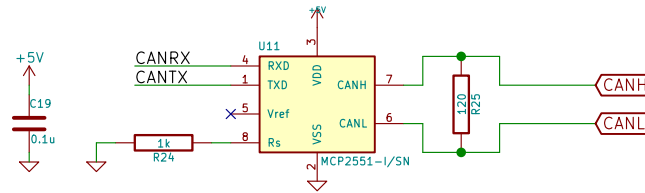
DEVELOPMENT ONLY	
Engineer: Geoff Nudge	
Supervisor: Christopher Nadovich	
Fall Semester 2015	
Lafayette College	
Sheet: /Safety Loop Wiring/	
File: safety_loop.sch	
Title: Battery Pack Management Computer	
Size: USLetter	Date: Tue 6 Oct 2015
KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable	Rev: 0.4
	Id: 3/6

GROUNDING LOW VOLTAGE



CANTXD CANTX
CANRXD CANRX

CAN TRANCEIVER



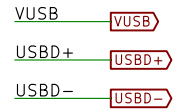
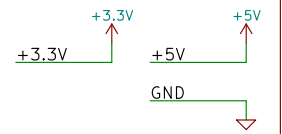
NOTE: Population of R26 is optional.
R26 should only be populated if you intend to use this board as a terminating CAN node. (R26 should usually be unpopulated).

DEVELOPMENT ONLY
Engineer: Geoff Nudge
Supervisor: Christopher Nadovich
Fall Semester 2015
Lafayette College
Sheet: /CAN Transceiver/
File: can_xcvr.sch

Title: Battery Pack Management Computer

Size: USLetter	Date: Tue 6 Oct 2015	Rev: 0.4
KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable		Id: 4/6

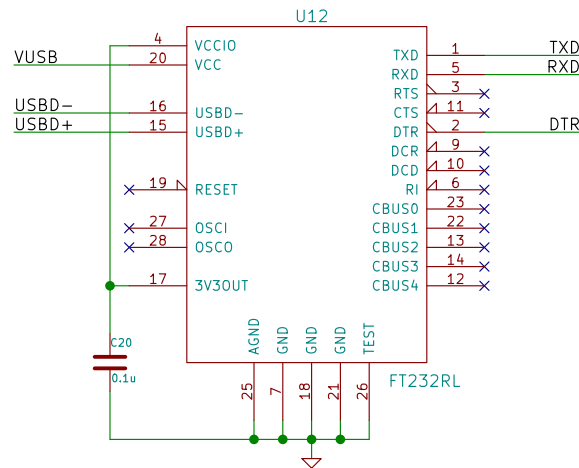
GROUNDING LOW VOLTAGE



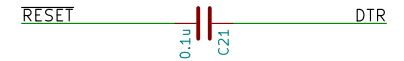
USB UART

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



FTDI Reset Connection



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.

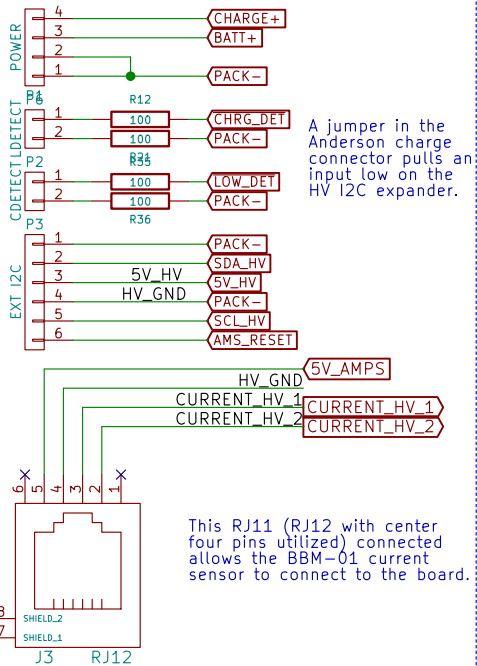


DEVELOPMENT ONLY
 Engineer: Geoff Nudge
 Supervisor: Christopher Nadovich
 Fall Semester 2015
Lafayette College
 Sheet: /FTDI USB UART/
 File: ftdi_uart.sch

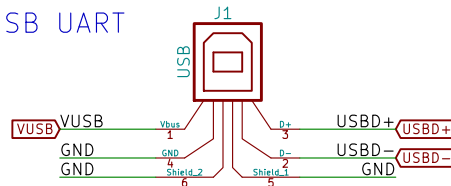
Title: Battery Pack Management Computer

Size: USLetter	Date: Tue 6 Oct 2015	Rev: 0.4
KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable		Id: 5/6

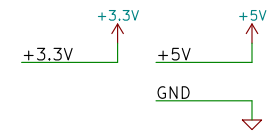
HIGH VOLTAGE



USB UART



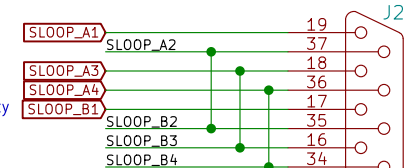
GROUNDING LOW VOLTAGE



PACK WIRING HARNESS APPLICATION NOTE

Port J2 is a DB-37 backplane connector, which will be connected to the pack wiring harness via solder pot connections. The wiring of this connector, and its inputs/outputs are described in more detail in the pack wiring diagram.

SAFETY LOOP A/B



SLOOP_A pins are shorted together only when the safety loop is closed

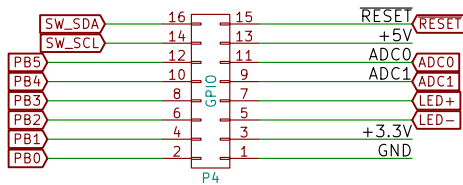
Pins in these sections are connected to obsolete signals in the test stand. They may be used, but the test stand must be updated as well.

FAN



GPIO HEADER

0.1" IDC Connector
External User Interface Board



This connector contains pins which can be used for SPI. If, at a later time, more complicated LCDs, or more I/O is required this feature can be utilized.

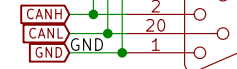
CHARGE 1/2

Charge Relay output, up to 5V & 1.5A can be used. A solid state or PCB-mount relay is recommended to keep current draw within specification. (current design uses Croydon D1D40)

LCD HEADER/SWI2C

This 4 wire connector is used to interface with an optional I2C LCD such as the DF-Robot 20x04 character display, or the Adafruit LCD Backpack. NOTE: This port is software I2C only.

GLV HARNESS

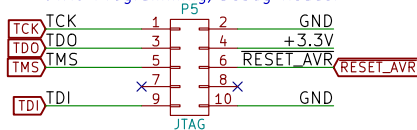


GLV HARNESS

This device only uses 3 pins from the GLV connector: CANH, CANL, and GLV_GND.

AVR DEBUGGING

JTAG Programming/Debug Header



DEVELOPMENT ONLY

Engineer: Geoff Nudge
Supervisor: Christopher Nadovich
Spring Semester 2016

Lafayette College

Sheet: /External Connectors/
File: connectors.sch

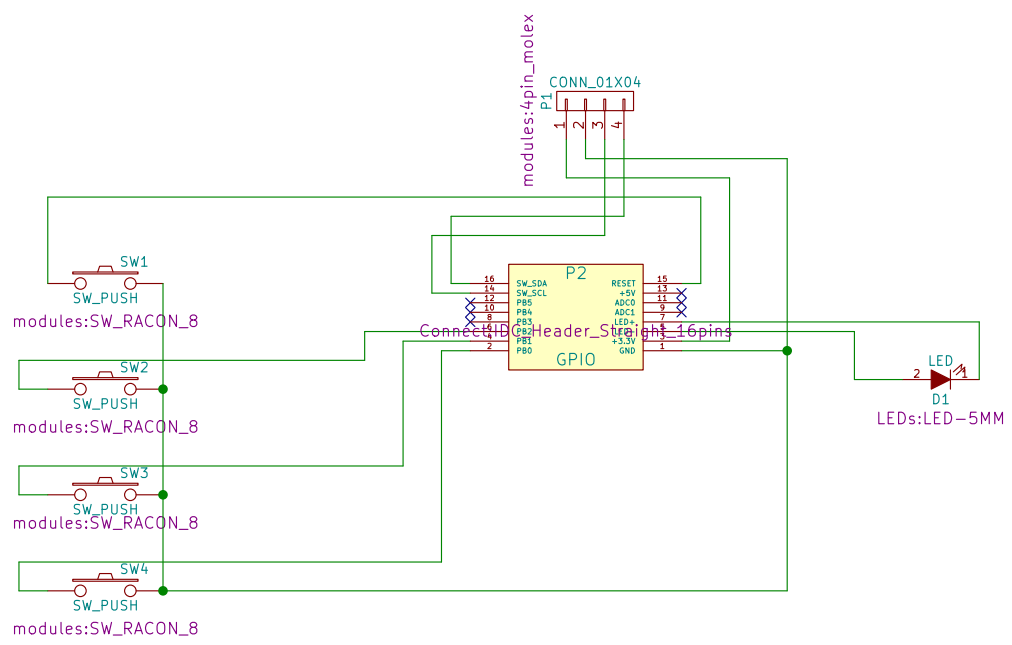
Title: Battery Pack Management Computer

Size: USLetter Date: Mar 03 2016

KiCad E.D.A. kicad 4.0.2-4+622538ubuntu14.04.1-stable

Rev: 0.4

Id: 6/6



Spring 2016		
Supervisor: Chirs Nadovich		
Engineer: Jaejoon Yang		
Lafayette College ECE		
Sheet: /		
File: panel pcb.sch		
Title:		
Size: A4	Date: Spring 2016	Rev: 0.1
KiCad E.D.A. kicad (2015-08-05 BZR 6055, Git fa29c62)-product		Id: 1/1