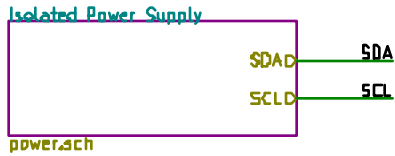
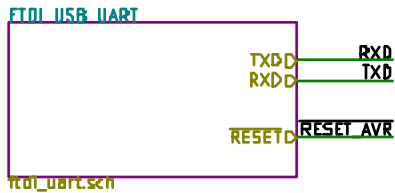


# POWER ELECTRONICS

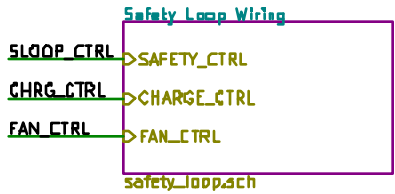
\*\*\*DC-DC Switching Power Regulation\*\*\*  
 5V and 3.3V outputs are isolated from High Voltage,  
 but not each other



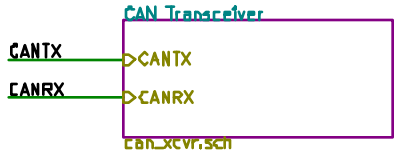
# FTDI USB UART



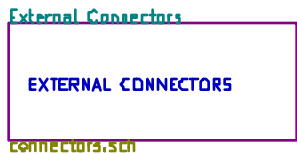
# SAFETY LOOP WIRING



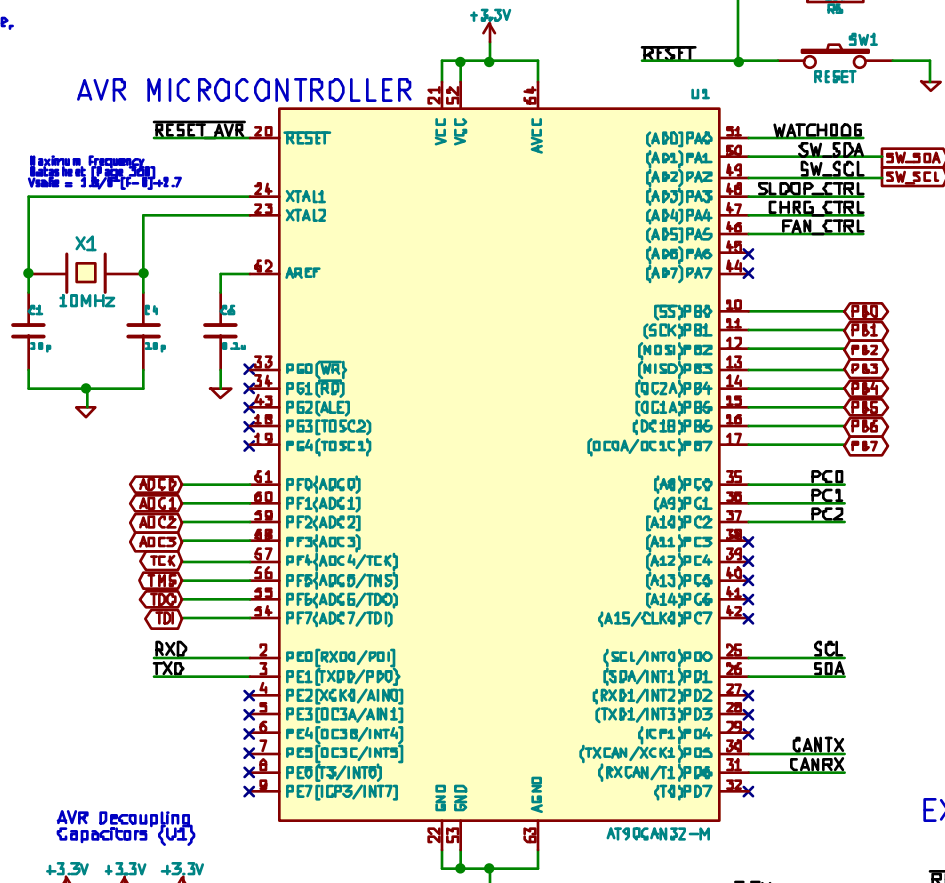
# CAN TRANCEIVER



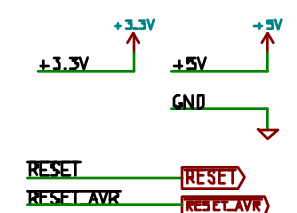
# CONNECTORS



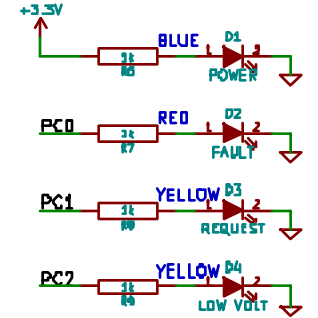
# AVR MICROCONTROLLER



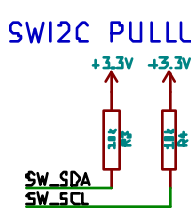
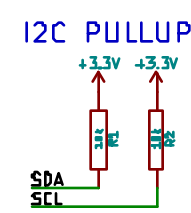
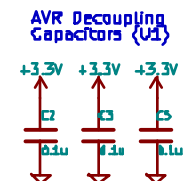
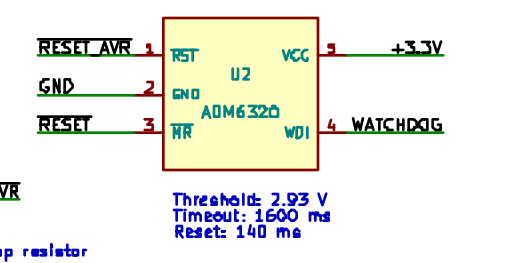
# GROUNDING LOW VOLTAGE



# SYSTEM STATUS LEDS

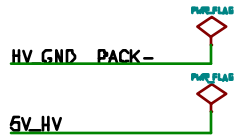
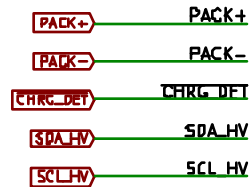


# EXTERNAL WATCHDOG

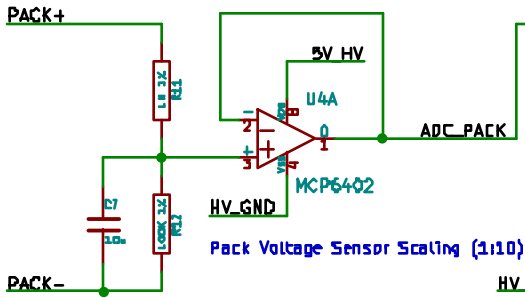


Engineer: John Getrig	
Supervisor: Christopher Nadovich	
Fall Semester 2010	
Lafayette College	
Sheet: /	
File: pacman-main.sch	
Title: Battery Pack Management Computer	
Size: USLetter	Date: Mon 9 Nov 2015
KiCad E.D.A. kicad [after 2015-may-25 BZR unknowns]-product	Rev: 0.3
	Id: 1/6

## HIGH VOLTAGE INTERFACES

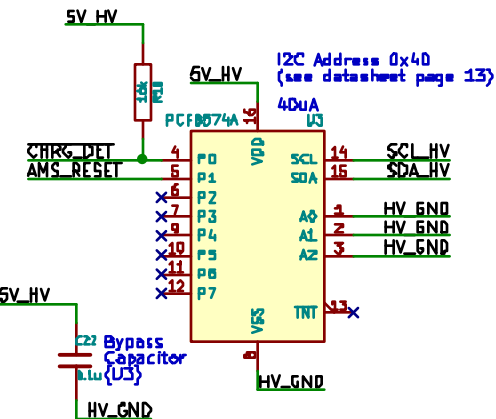


## PACK VOLTAGE SENSOR



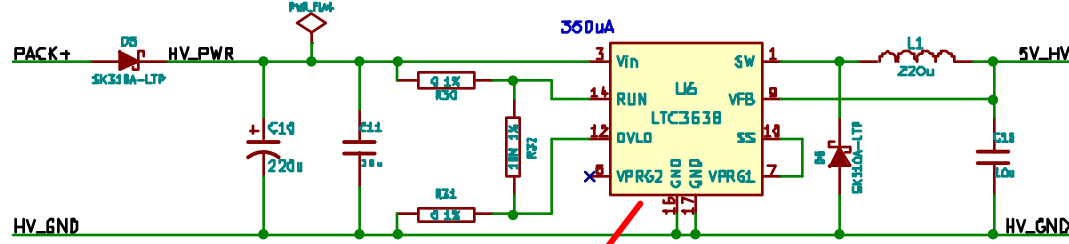
## HIGH VOLTAGE DIGITAL I/O

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



## HIGH VOLTAGE POWER

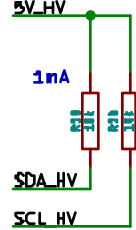
This power supply is responsible for delivering non-isolated 5V power to the high voltage electronics. All AMS bas connected devices are powered from this regulator. Maximum current draw 250mA. This Switcher was selected for its high efficiency even at light load.



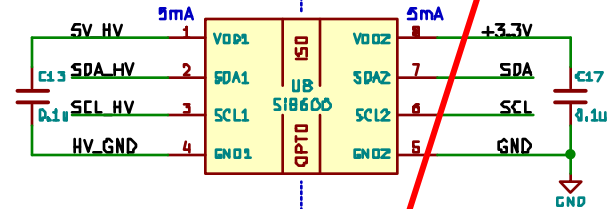
Modify Footprint, See PCB PDF

I2C Address 0x48 (see datasheet page 14)

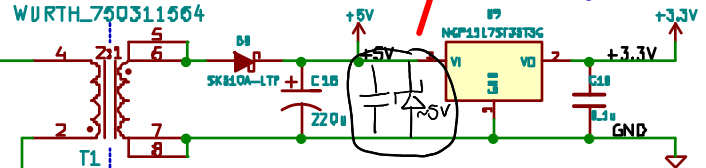
## I2C PULLUP



## I2C ISOLATOR



## HIGH VOLTAGE LOW VOLTAGE



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. It is not recommended to run any digital logic, or sensitive ICs from this source.

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

Engineer John Getrig  
 Supervisor: Christopher Nadovich  
 Fall Semester 2010  
 Lafayette College

Title: Battery Pack Management Computer

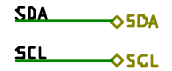
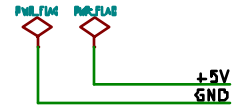
Size: USLetter Date: Mon 9 Nov 2015 Rev: 0.3  
 KICad E.D.A. kicad (after 2015-may-25 82R unknowns)-product Id: 2/6

Wrong Value, Should be ~115K 1% See LT8302 Datasheet Page 11

This should be a precision 1% Resistor

## HIGH VOLTAGE

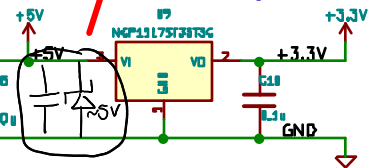
## LOW VOLTAGE



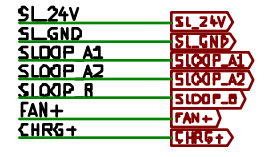
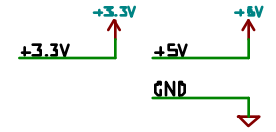
Zener Diode ~5V should be added to protect against overvoltage in low current scenarios

SFC Capacitor should be added ~0.1uF to smooth voltage ripples

## 3.3V Linear Regulator



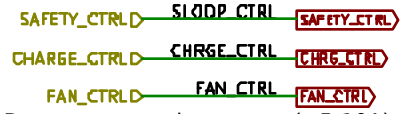
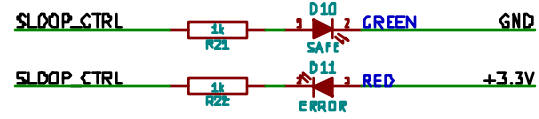
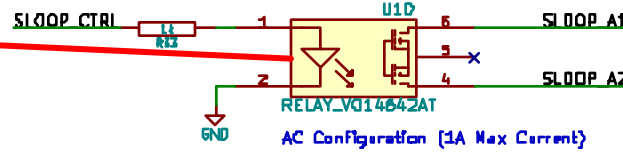
## GROUNDING LOW VOLTAGE



SLOOP\_A pins are shorted together only when the safety loop is closed  
 SLOOP\_B pins are always shorted together

## 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 1A in AC configuration.



Does not meet the current (~5-10A) requirement for the safety loop... Would work for one maybe 2 AIRS relays.

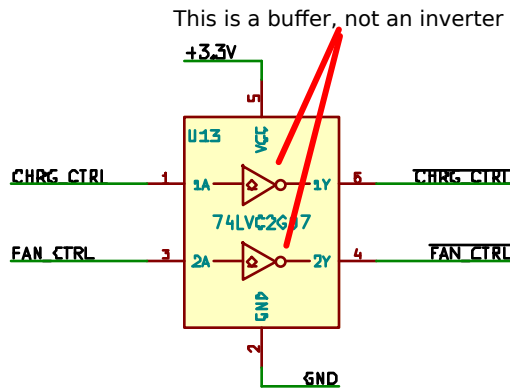
It might be possible to replaced this with an external automotive relay?

Something like (Cooper Bussmann 15303-5-2-4) might work well to hold it all...

an automotive NO relay.

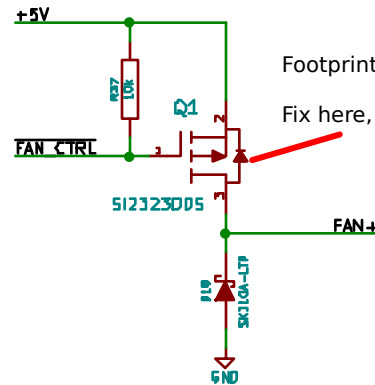
## HIGH SIDE P-FET DRIVER

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



## FAN CONTROL N-FET

This MOSFET is responsible for switching the charge fan DN/OFF.  
 The fan will not come on automatically when charging begins, it is controlled by the software.  
 Fan Output Voltage: 5V

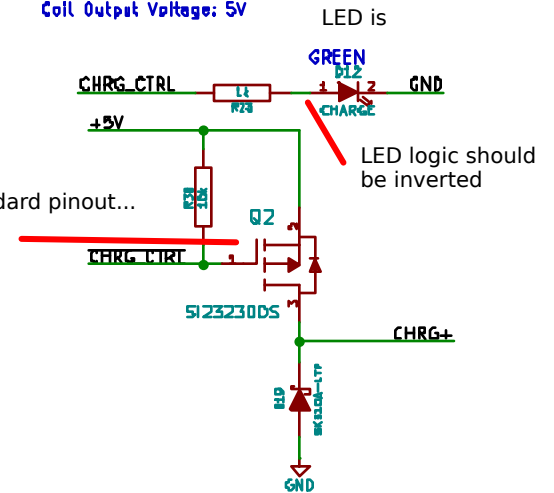


Footprint uses non standard pinout...  
 Fix here, or in footprint

## CHARGE CONTROL N-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

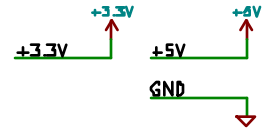


### APPLICATION NOTE:

The 5V line is not tightly regulated in low load scenarios. All devices attached to the 5V rail should be tolerant to voltage spikes of around 20%.

Engineer John Getrig	
Supervisor: Christopher Nadovich	
Fall Semester 2010	
Lafayette College	
Sheet: /Safety Loop Wiring/	
File: safety_loop.sch	
Title: Battery Pack Management Computer	
Size: USLetter	Date: Mon 9 Nov 2015
KICad E.D.A. kicad (after 2015-may-25 BZR unknowns)-product	Rev: 0.3
	Id: 3/6

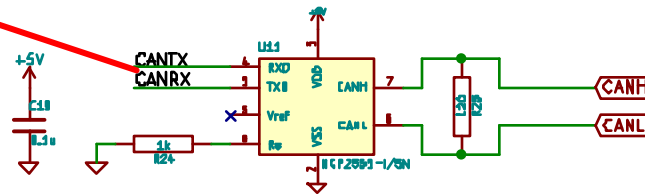
GROUNDING LOW VOLTAGE



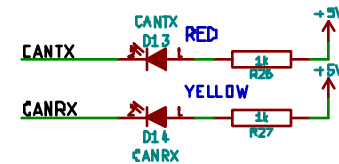
CANTXD --- CANTX  
 CANRXD --- CANRX

These signals are bass ackwards  
 CANTX --> CANRX  
 CANRX --> CANTX

CAN TRANCEIVER



NOTE: Population of R25 is optional.  
 R25 should only be populated if you intend  
 to use this board as a terminating CAN node.  
 (R25 should usually be unpopulated).

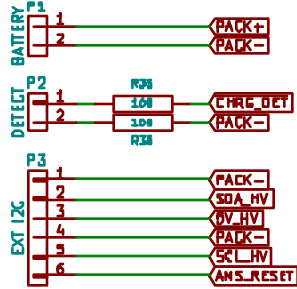


These LEDs aren't particularly useful, might  
 be worth removing them... Maybe replace them  
 with a CAN REQ/Generic LED?

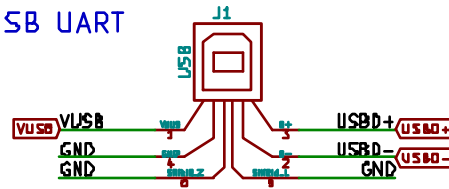
Engineer John Getrig Supervisor: Christopher Nadovch Fall Semester 2010 Lafayette College	
Sheet: /CAN Transceiver/ File: can_xcvr.sch	
<b>Title: Battery Pack Management Computer</b>	
Size: USLetter	Date: Mon 9 Nov 2015
KICad E.D.A. kicad [after 2015-may-25 BZR unknown]-product	Rev: 0.3 Id: 4/6



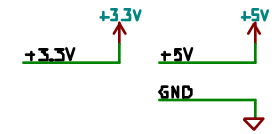
## HIGH VOLTAGE



## 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

SLLOOP\_A pins are shorted together only when the safety loop is closed

SLLOOP\_B pins are always shorted together

## GLV HARNESS

This device only uses 3 pins from the GLV connector (CANH, CANL, and GLV\_GND).

## 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.

## 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.

## SAFETY LOOP A

## SAFETY LOOP B

## AIRS 1

## AIRS 2

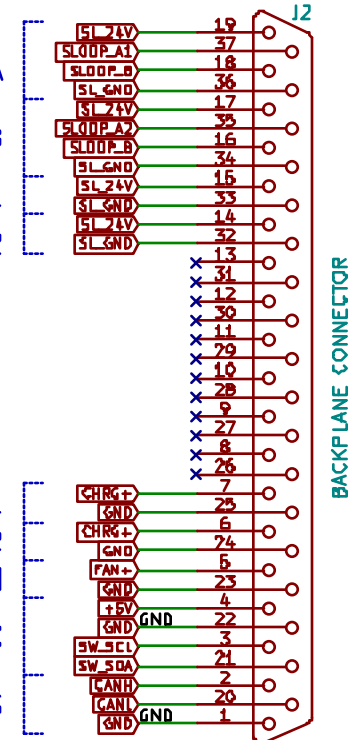
## CHARGE 1

## CHARGE 2

## FAN

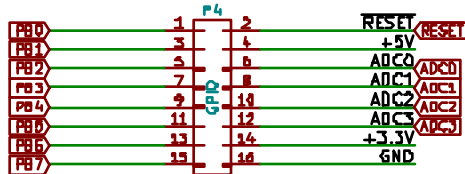
## LCD HEADER/SWI2C

## GLV HARNESS



## GPIO HEADER

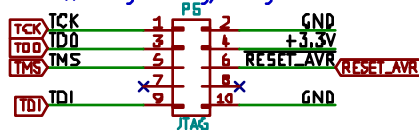
0.1" IDC Connector  
External User Interface Board



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.

## AVR DEBUGGING

JTAG Programming/Debug Header



Engineer John Getrig  
Supervisor: Christopher Nadovich  
Fall Semester 2010  
Lafayette College

Sheet: /External Connectors/  
File: connectors.sch

Title: Battery Pack Management Computer

Size: USLetter Date: Mon 9 Nov 2015

Rev: 0.3

KICad E.D.A. kicad (after 2015--may--25 8ZR unknowns)--product

Id: 6/6