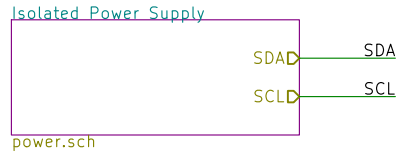
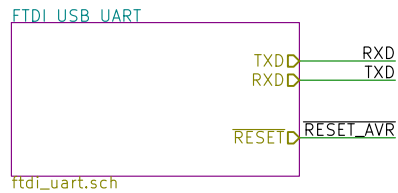


## POWER ELECTRONICS

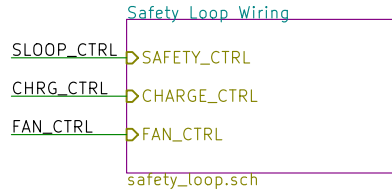
**\*\*DC-DC Switching Power Regulation\*\***  
5V and 3.3V outputs are isolated from High Voltage, but not each other



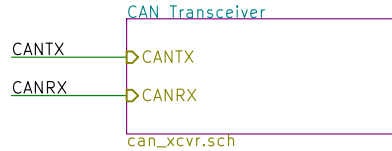
## FTDI USB UART



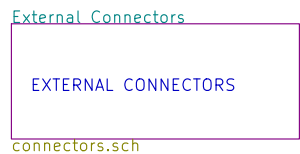
## SAFETY LOOP WIRING



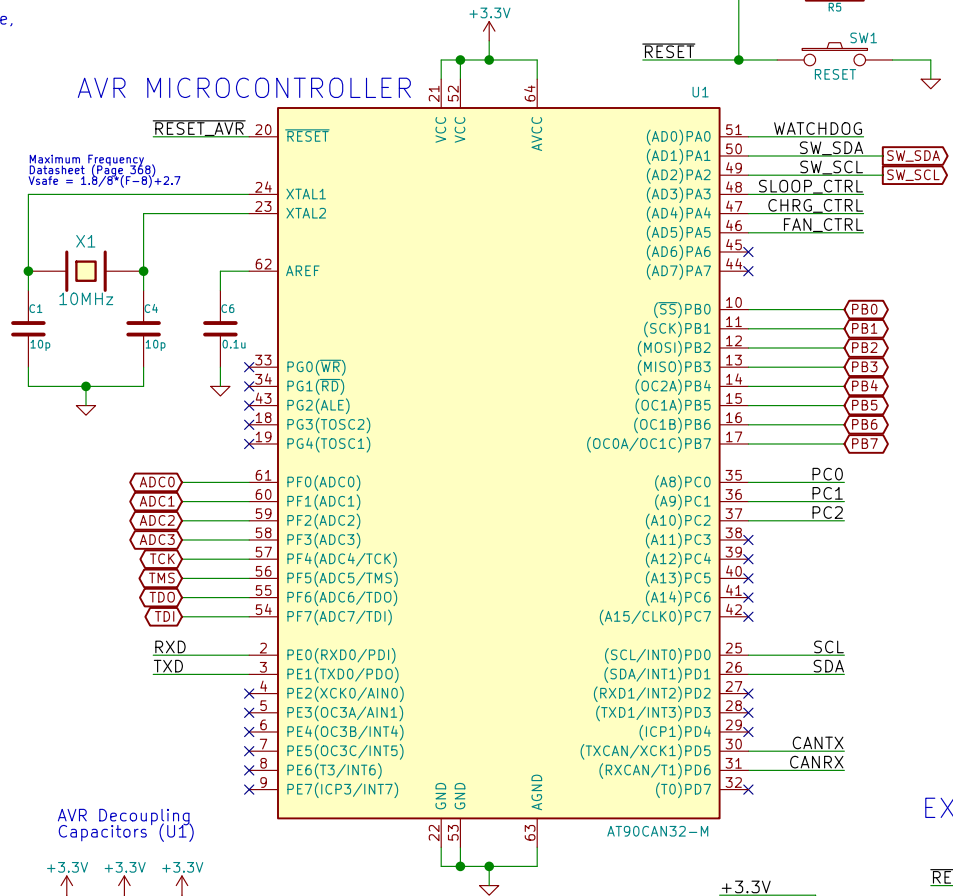
## CAN TRANCEIVER



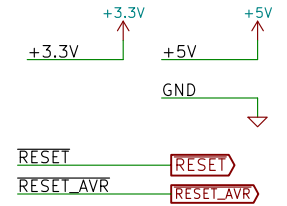
## CONNECTORS



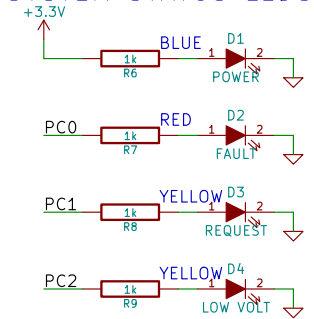
## AVR MICROCONTROLLER



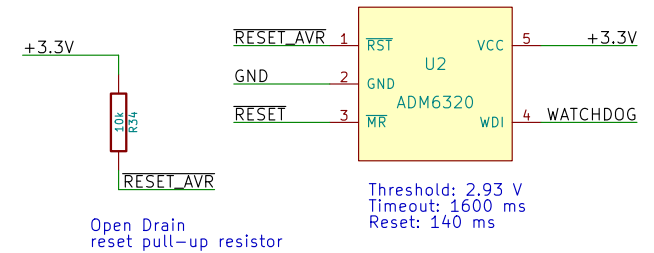
## GROUNDING LOW VOLTAGE



## SYSTEM STATUS LEDs



## EXTERNAL WATCHDOG



Engineer: John Gehrig  
Supervisor: Christopher Nadovich  
Fall Semester 2015  
**Lafayette College**  
Sheet: /  
File: pacman-main.sch

### Title: Battery Pack Management Computer

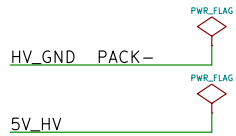
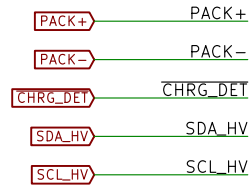
Size: USLetter Date: Mon 9 Nov 2015

KiCad E.D.A. kicad (after 2015-may-25 BZR unknown)-product

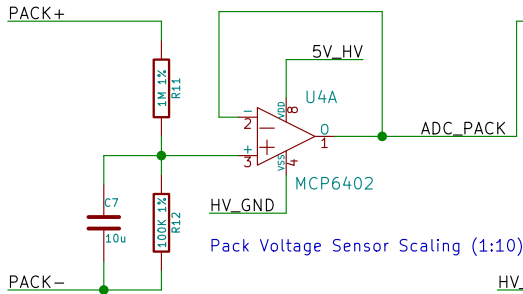
Rev: 0.3

Id: 1/6

## HIGH VOLTAGE INTERFACES

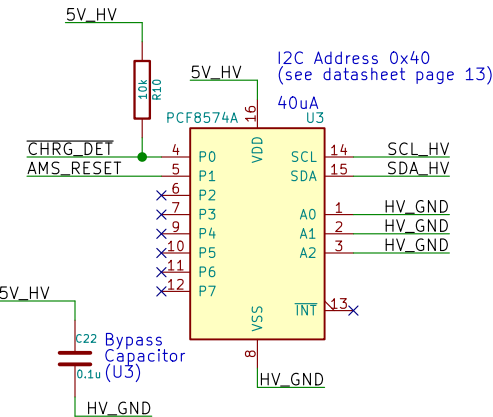


## PACK VOLTAGE SENSOR



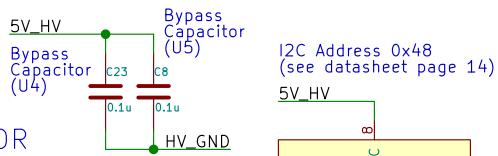
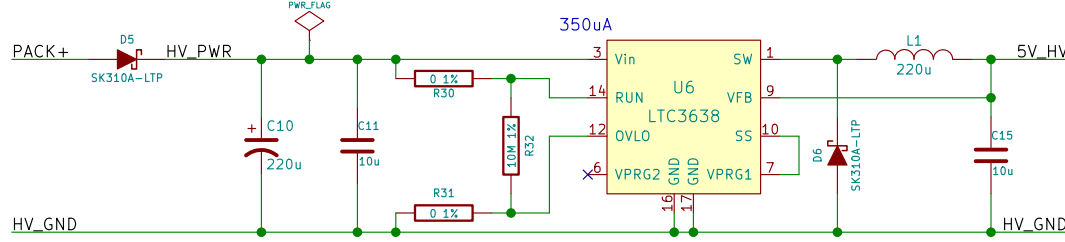
## HIGH VOLTAGE DIGITAL I/O

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

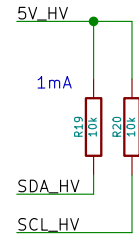


## HIGH VOLTAGE POWER

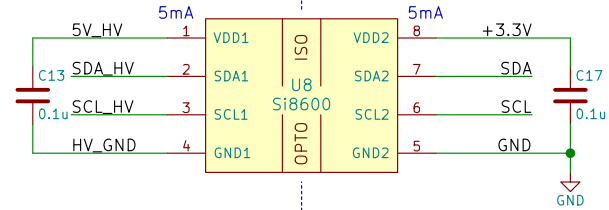
This power supply is responsible for delivering non-isolated 5V power to the high voltage electronics. All AMS bus connected devices are powered from this regulator. Maximum current draw 250mA. This Switcher was selected for its high efficiency even at light load.



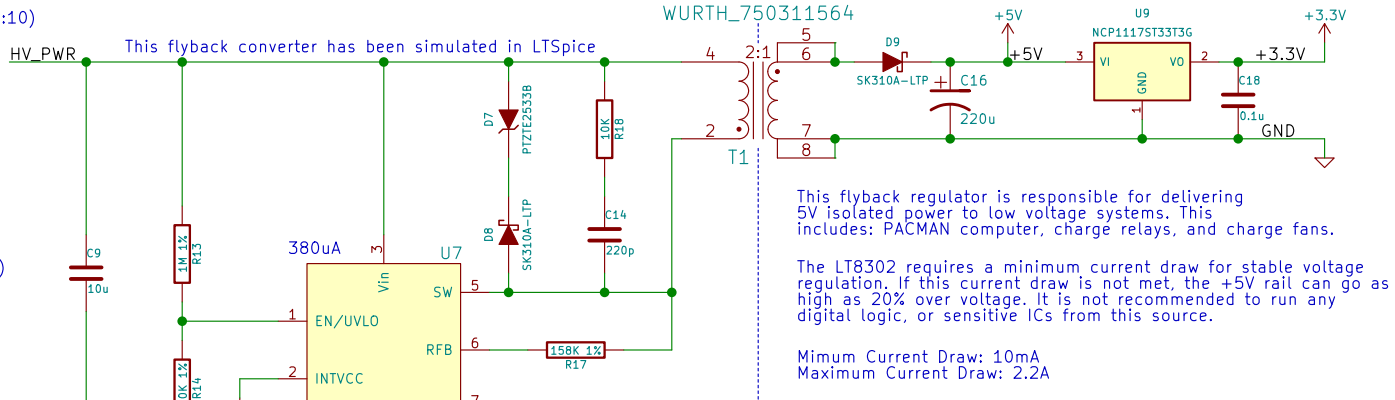
## I2C PULLUP



## 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 Gehrig  
 Supervisor: Christopher Nadovich  
 Fall Semester 2015

Lafayette College

Sheet: /Isolated Power Supply/  
 File: power.sch

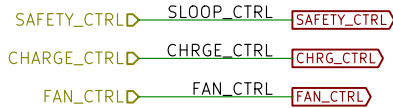
### Title: Battery Pack Management Computer

Size: USLetter Date: Mon 9 Nov 2015

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Rev: 0.3

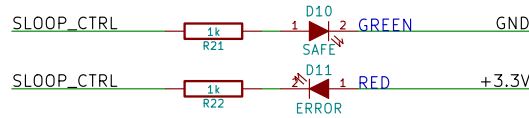
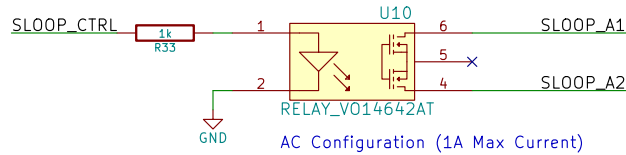
Id: 2/6



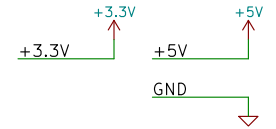
### SAFETY LOOP RELAY

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 1A in AC configuration.

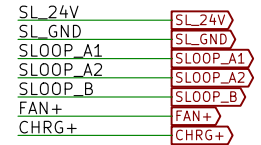


### GROUNDING LOW VOLTAGE



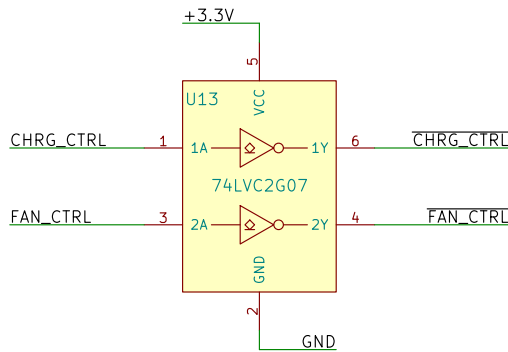
SLOOP\_A pins are shorted together only when the safety loop is closed

SLOOP\_B pins are always shorted together



### HIGH SIDE P-FET DRIVER

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

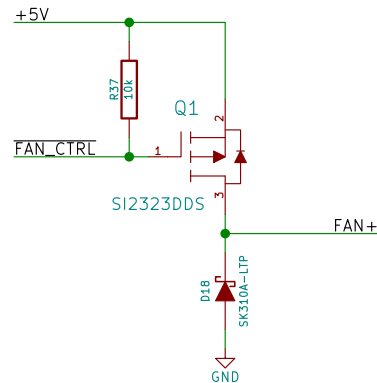


### FAN CONTROL N-FET

This MOSFET is responsible for switching the charge fan ON/OFF.

The fan will not come on automatically when charging begins, it is controlled by the software.

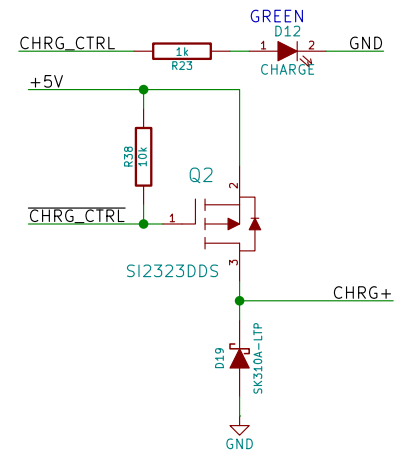
Fan Output Voltage: 5V



### 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 Gehrig  
Supervisor: Christopher Nadovich  
Fall Semester 2015

Lafayette College

Sheet: /Safety Loop Wiring/  
File: safety\_loop.sch

**Title: Battery Pack Management Computer**

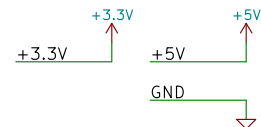
Size: USLetter Date: Mon 9 Nov 2015

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Rev: 0.3

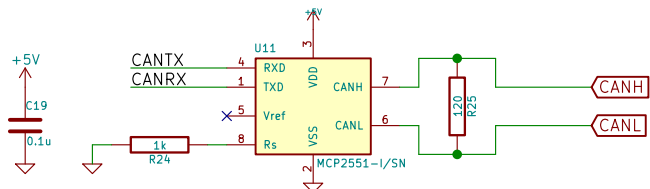
Id: 3/6

GROUNDING LOW VOLTAGE

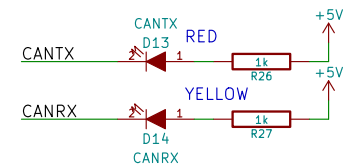


CANTXD — CANTX  
 CANRXD — CANRX

### CAN TRANCEIVER

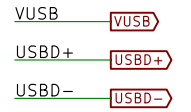
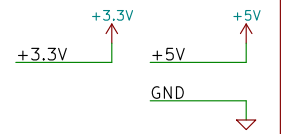


NOTE: Population of R26 is optional.  
 R26 should only be populated if you intend to use this board as a terminating CAN node. (R26 should usually be unpopulated).



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

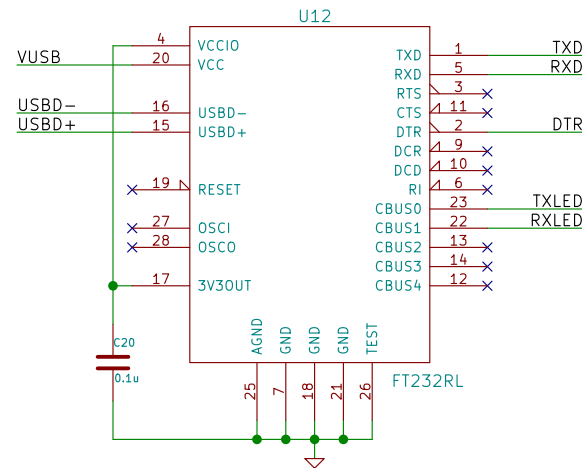
## GROUNDING LOW VOLTAGE



## 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



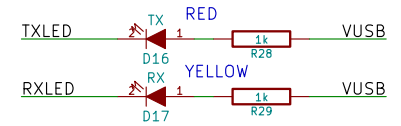
## USB BOOTSTRAP POWER

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.



## UART LEDS

These LEDs light when USB serial data is being transmitted.



## FTDI Reset Connection



Engineer: John Gehrig  
Supervisor: Christopher Nadovich  
Fall Semester 2015

**Lafayette College**

Sheet: /FTDI USB UART/  
File: ftdi\_uart.sch

### Title: Battery Pack Management Computer

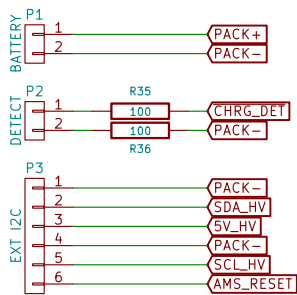
Size: USLetter Date: Mon 9 Nov 2015

Rev: 0.3

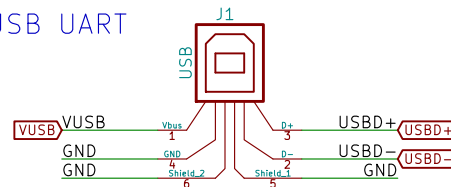
KiCad E.D.A. kicad (after 2015-may-25 BZR unknown)-product

Id: 5/6

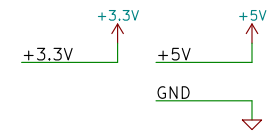
## HIGH VOLTAGE



## 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

SLOOP\_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

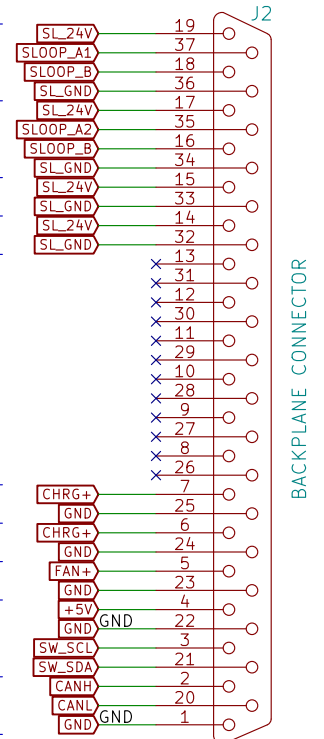
This 4 wire connector is used to interface with an optional I2C LCD such as the DF-Robot 20x04 character display, or the Adafruit LCD Backpack. NOTE: This port is software I2C only.

## SAFETY LOOP A

## SAFETY LOOP B

## AIRS 1

## AIRS 2



## CHARGE 1

## CHARGE 2

## FAN

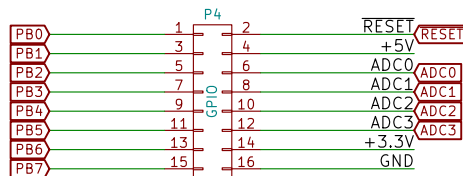
## LCD HEADER/SWI2C

## GLV HARNESS

BACKPLANE CONNECTOR

## GPIO HEADER

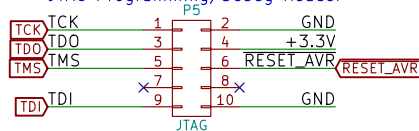
0.1" IDC Connector  
External User Interface Board



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 Gehrig  
Supervisor: Christopher Nadovich  
Fall Semester 2015

Lafayette College

Sheet: /External Connectors/  
File: connectors.sch

**Title: Battery Pack Management Computer**

Size: USLetter Date: Mon 9 Nov 2015

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Rev: 0.3

Id: 6/6