POWER ELECTRONICS

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

Sheet: Isolated Power Supply
SDA
SCL
File: power.sch

FTDI USB UART

Sheet: FTDI USB UART
TXD
RXD
RESET
RXD
TXD
RESET_AVR
File: ftdi_uart.sch

SAFETY LOOP WIRING

Sheet: Safety Loop Wiring
SLOOP_CTRL
CHRG_CTRL
FAN_CTRL
SAFETY_CTRL
CHARGE_CTRL
FAN_CTRL
File: safety_loop.sch

CAN TRANCEIVER

Sheet: CAN Transceiver
CANTX
CANRX
CANTX
CANRX
File: can_xcvr.sch

CONNECTORS

Sheet: External Connectors
EXTERNAL CONNECTORS
PB0
PB1
PB2
PB3
PB4
PB5
File: connectors.sch

AVR MICROCONTROLLER

U1
AT90CAN128-M
RESET_AVR
Maximum Frequency
Datasheet (Page 368)
Vsafe = 1.8/8*(F-8)+2.7
X1
10MHz
C1 10p
C4 10p
C6 0.1u
ADC0
ADC1
TCK
TMS
TDO
TDI
RXD
TXD
SCL
SDA
SW_SCL
SW_SDA
CANTX
CANRX
WATCHDOG
SLOOP_DET
SLOOP_CTRL
CHRG_CTRL
FAN_CTRL
PB0
PB1
PB2
PB3
PB4
PB5
PC0
PC1

AVR Reset Switch

SW1
RESET

AVR Decoupling Capacitors (U1)

C2 0.1u
C3 0.1u
C5 0.1u

I2C PULLUP

R1 10k
R2 10k
SDA
SCL

EXTERNAL WATCHDOG

U2
ADM6320
RST
GND
MR
VCC
WDI
C18 0.1u
C26 0.1u
R34 10k
Threshold: 2.93 V
Timeout: 1600 ms
Reset: 140 ms
Open Drain
reset pull-up resistor

GROUNDED LOW VOLTAGE

SYSTEM STATUS LEDS

GREEN D1 POWER
RED D2 FAULT
GREEN D3 SPARE
R6 1k
R7 1k
R8 1k

HIGH VOLTAGE INTERFACES

BATT+
PACK+
PACK−
LOW_DET
CHRG_DET
SDA_HV
SCL_HV
5V_AMPS
AMPS_1
AMPS_2

PWR_FLAG
HV_GND
PACK−
PWR_FLAG
5V_HV

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.

PACK+ F1 1 A SK310A−LTP D5 HV_PWR PWR_FLAG
R13 1.1k C10 220u C11 1u
HV_GND

350uA
U6 LTC3638
Vin SW RUN VFB OVLO SS VPRG2 VPRG1 GND
L1 220u
D6 SK310A−LTP
R14 1k C15 10u C12 10u
5V_HV HV_GND

Bypass Capacitor (U4) C23 0.1u C8 0.1u
Bypass Capacitor (U5)
5V_HV HV_GND

I2C Address 0x48 (see datasheet page 14)
U5 ADS1115
AIN0 AIN1 AIN2 AIN3 VCC ADDR RDY SDA SCL GND
AMPS_1 AMPS_2 HV_GND SDA_HV SCL_HV

PACK VOLTAGE SENSOR AND CHARGE SENSOR

PACK+ 5V_HV
U4 INA_226
ALERT VBUS IN+ IN− VS A1 A0 SDA SCL GND
R3 0.001 1%
BATT+ HV_GND SDA_HV SCL_HV

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

I2C PULLUP

5V_HV
1mA
R19 1k R20 1k
SDA_HV SCL_HV

I2C ISOLATOR

5mA 5V_HV SDA_HV SCL_HV HV_GND
U8 Si8600
VDD1 SDA1 SCL1 GND1 ISO OPTO VDD2 SDA2 SCL2 GND2
5mA +3.3V SDA SCL GND
C14 C25 C13 0.1u 0.1u 0.1u C17 0.1u

HIGH VOLTAGE DIGITAL I/O

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

I2C Address 0x40 (see datasheet page 13)
5V_HV R10 10k
U3 PCF8574A
P0 P1 P2 P3 P4 P5 P6 P7 VDD VSS SCL SDA A0 A1 A2 INT
CHRG_DET AMS_RESET LOW_DET
SCL_HV SDA_HV HV_GND HV_GND HV_GND
40uA
Q4 RRR015P03TL 5V_AMPS 5V_HV
R11 10k 5V_HV
HV_GND

5V_HV C22 0.1u Bypass Capacitor (U3) HV_GND

HIGH VOLTAGE | LOW VOLTAGE

HV_PWR C9 10u HV_GND
U7 NCS6S1205C
VIN+ VIN+ VIN− VIN− VOUT+ VOUT− NC
D9 SK310A−LTP
+5V C16 220u C24 0.1u D20 NZH5V1B
3.3V Linear Regulator
U9 NCP1117ST33T3G VI VO GND
+5V +3.3V C27 10u GND

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.

Maximum Current Draw on 5V output: 1.2A

HIGH VOLTAGE | LOW VOLTAGE

5V_HV 5V_HV
AMS_RESET AMS_RESET

PWR_FLAG PWR_FLAG +5V GND
SDA SDA
SCL SCL

SAFETY_CTRL — SLOOP_CTRL

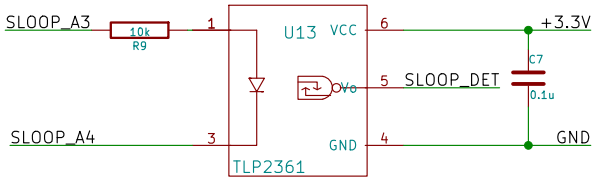
CHARGE_CTRL — CHRG_CTRL

FAN_CTRL — FAN_CTRL

SLOOP_DET — SLOOP_DET

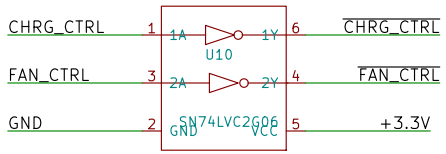
OPTO-ISOLATOR ON SL CLOSED SIGNAL

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 mean the AIRs should be closed if functional.



HIGH SIDE P-FET DRIVER

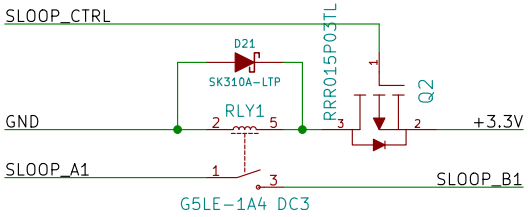
This device is responsible for driving the high side p-fet switches.



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 safey loop is open or closed.

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

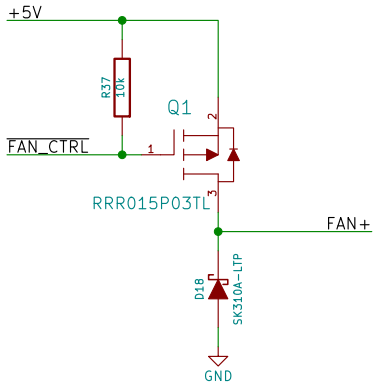


FAN CONTROL P-FET

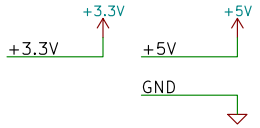
This MOSFET is responsible for switching the charge fan ON/OFF.

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

Fan Output Voltage: 5V

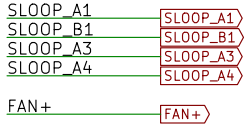


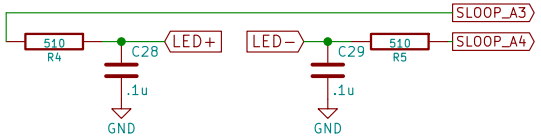
GROUNDED LOW VOLTAGE



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.

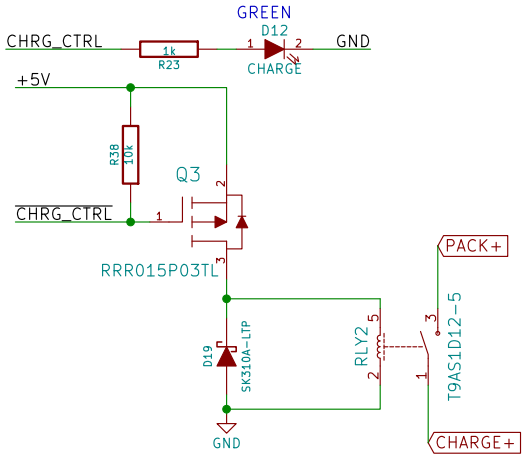




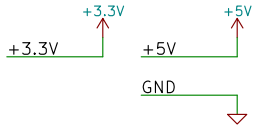
CHARGE CONTROL P-FET

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.

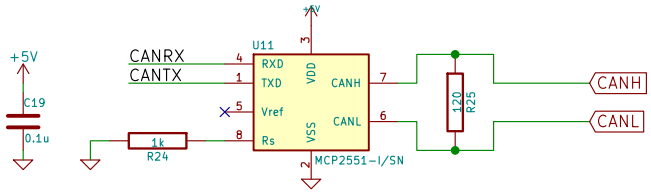
Coil Output Voltage: 5V



GROUNDED LOW VOLTAGE



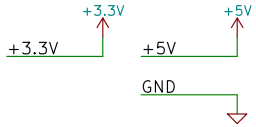
CAN TRANCEIVER

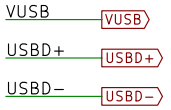


NOTE: DO NOT populate R25.

R25 provides the ability to use this board
as a terminating CAN node in development only.

GROUNDED LOW VOLTAGE





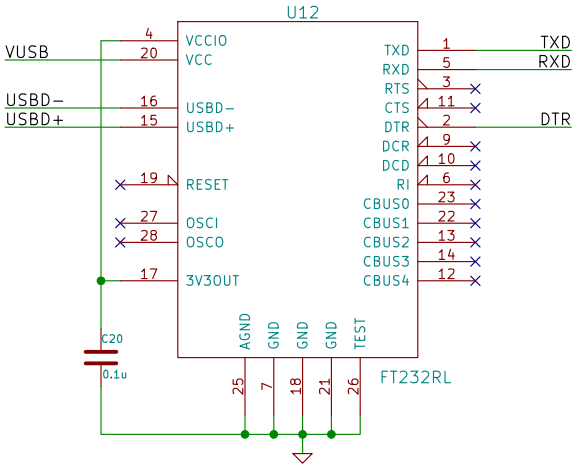
USB BOOTSTRAP POWER

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.

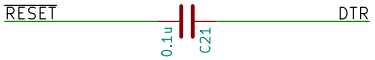
USB UART

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.

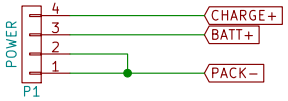
Drivers available for Windows, Mac OS & Linux

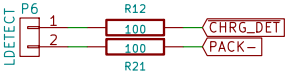


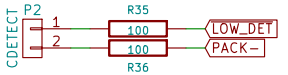
FTDI Reset Connection



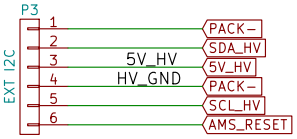
HIGH VOLTAGE

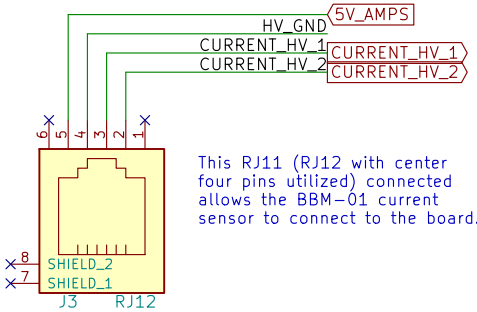






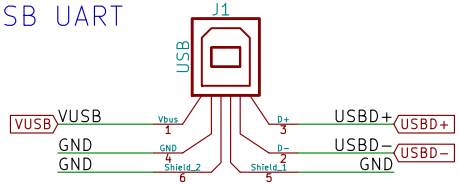
A jumper in the Anderson charge connector pulls an input low on the HV I2C expander, corresponding to either charge or low current output.





This RJ11 (RJ12 with center four pins utilized) connected allows the BBM−01 current sensor to connect to the board.

USB UART

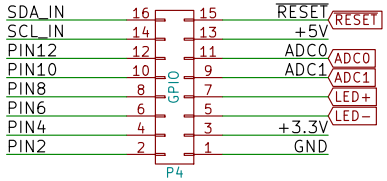


PACK WIRING HARNESS APPLICATION NOTE

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.

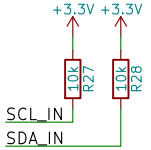
GPIO HEADER

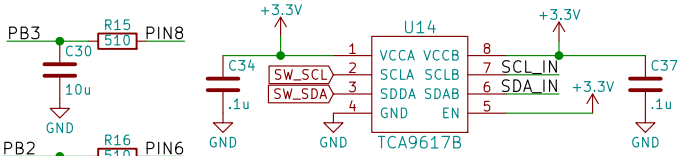
0.1" IDC Connector
External User Interface Board

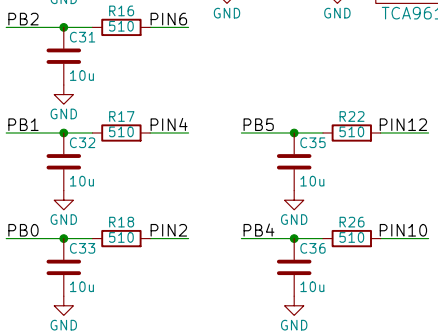


This connector contains pins for I2C communication with the LCD screen, input from control panel push buttons, and to illuminate the pack alile LED. . If, at a later time, more complicated LCDs, or more I/O is required these pins can be utilized.

I2C PULLUP

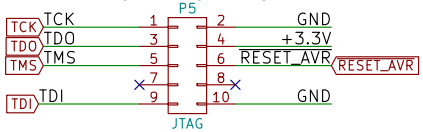




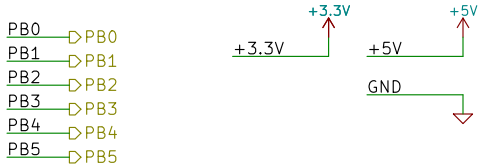


AVR DEBUGGING

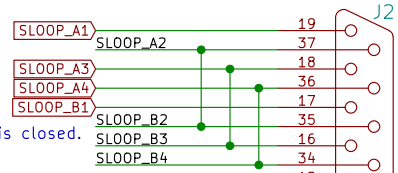
JTAG Programming/Debug Header



GROUNDED LOW VOLTAGE



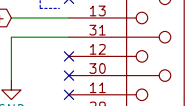
SAFETY LOOP A/B



SLOOP_A1 and SLOOP_B1 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



GLV HARNESS