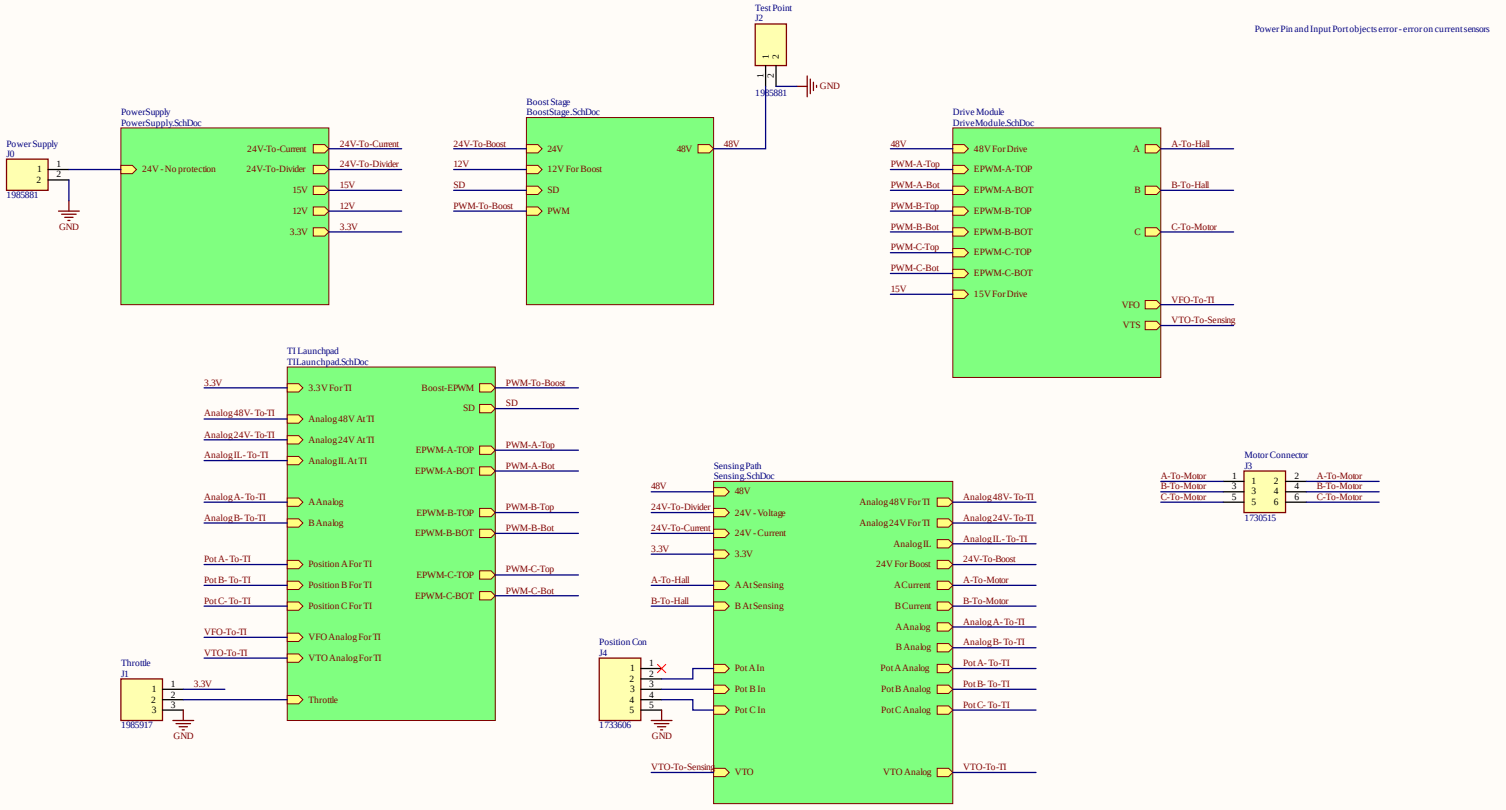
EE 453 Electric Bike PCB

Nolan, Bennett, Seth



Title	EE 453 Capstone		UW-Seattle 185 Stevens Way Paul Allen Center Seattle, WA US-98195
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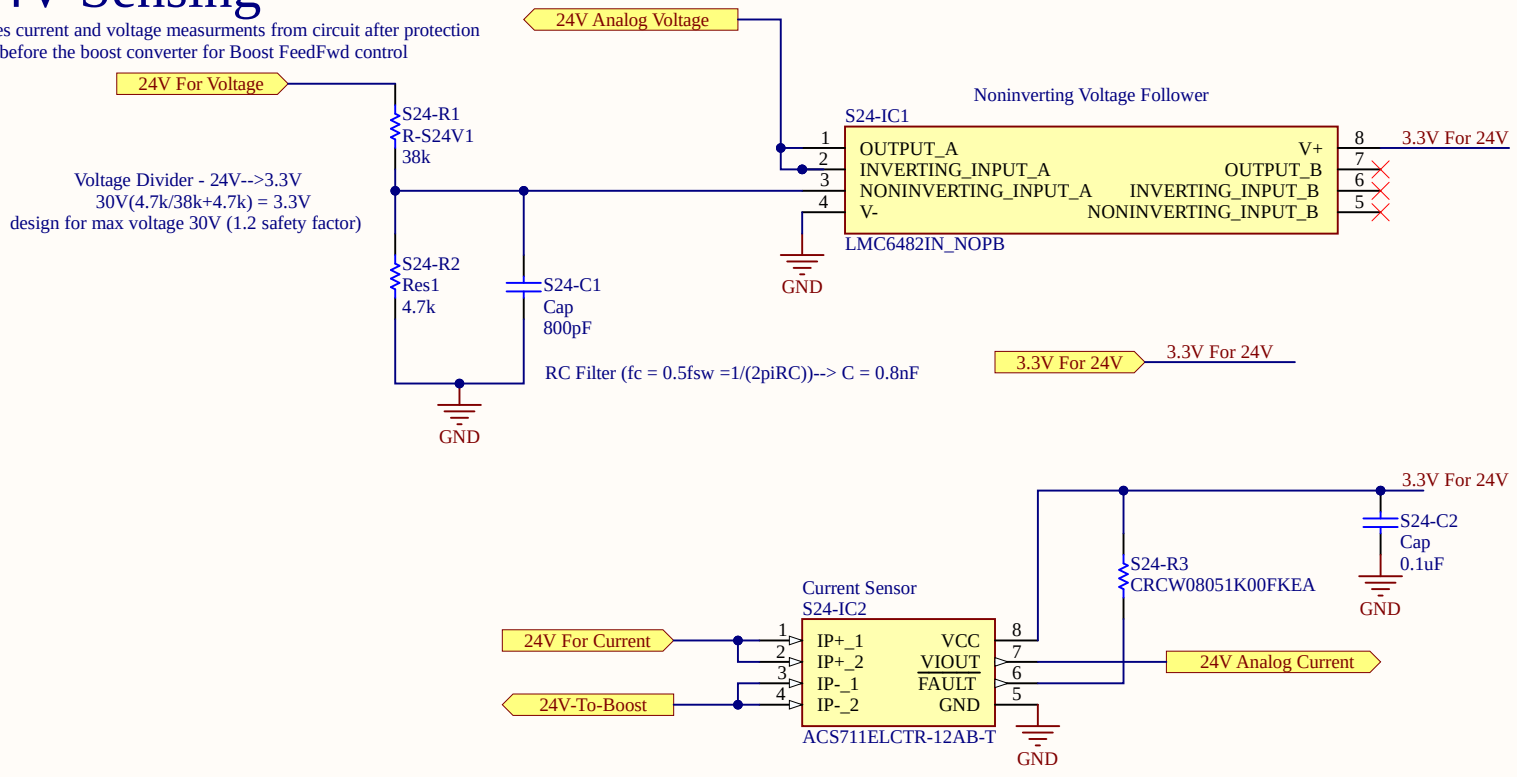
Date: 4/11/2021	Time: 7:02:16 PM	Sheet 1 of 1	
File: C:\Users\Nolan Kim\Documents\School\Sp21\EE 453\ee453_pcb_N-B-See453_pcb_N-B-S.SchDoc			

24V Sensing

Takes current and voltage measurments from circuit after protection and before the boost converter for Boost FeedFwd control



S24-R3 for fault sensing
measuring not implemented
added just in case we decide otherwise

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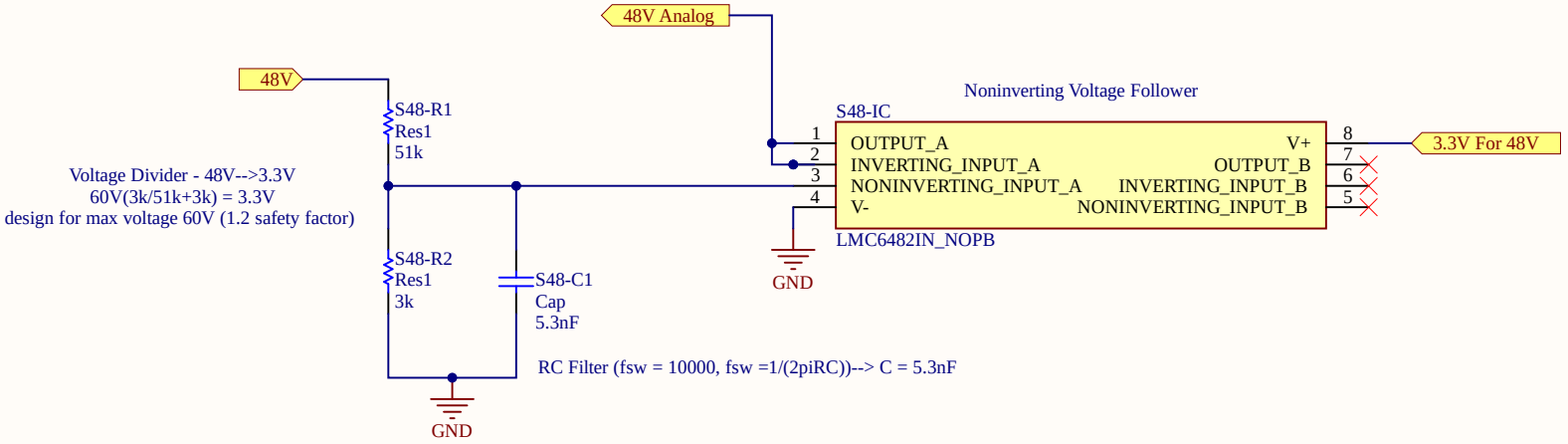
48V Sensing

Takes voltage measurements from the boost stage after protection before the integrated power module.



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Inductor
BS-L1

24V

B66366B1018T001

Inductor

Inductance calcs
L=(V_L*D*T_s)/(2*delta i)
L=(24*0.5*1*10^-4)/(0.6)
L=2mH

Inductor Calcs
Chose a switching freq of 10kHz
Assume D=0.5, T_s = 1/f_s=1/10,000kHz
V_L=V_g - (V_RL + V_Ron)=24 - (a really small number)
2*delta i = 15/100 * i_L = 15/100 * 4 = 0.6
* Note: Assume 15% ripple desired

Capacitor Calcs
assume 1% ripple, D = 0.5, double capacitance after calculating
C=(i_c*D*T_s)/(2*delta v)
i_c = Power/Voltage = 200W/48V = 4.17A
2 * delta v = 0.01 * 48 = 0.48 V
C = (4.17*0.5*1/10000)/(0.48) = 434 uF
Doubling calculated capacitance, so C = 868 uF
80% electrolytic: ~695 uF
1x 470 uF, 2x 100 uF, 1x 22 uF
20% ceramic/film: ~174 uF
1x 27 uF, 1x 150 uF

pin 2 is drain
pin 3 is source

Gate Driver
BS-IR2184
DILB8P-223TLF

PWM
SD
GND
VS
HO
LO
12V For Boost

BS-Dboot
SB3H100-E3_54
BS-Rboot
Res1
10K
BS-Cboot
K104K10X7RF5UH5
0.1 uF boot capacitor

BS-C1
K104K10X7RF5UH5
0.1 uF

BS-R1
Res1
8

BS-R2
Res1
10

BS-D1
1N4148

BS-R3
Res1
8

BS-R4
Res1
10

BS-D2
1N4148

BS-R5
Res1
10K

BS-MOS1
IPP200N15N3_G

BS-CR
Part Number: P6KE91A

0.1 uF
BS-C2
K104K10X7RF5UH5

BS-MOS2
IPP200N15N3_G

BS-R6
Res1
10K

BS-RV
V68ZS10P

BS-C4
EEU-FS2A470

BS-C6
EEU-FS2A470

BS-C3
EEU-FS2A470

BS-C5
EEU-FS2A470

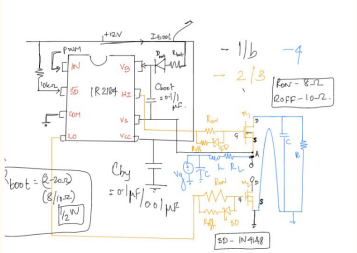
BS-C8
GRM21BR71H104KA01L

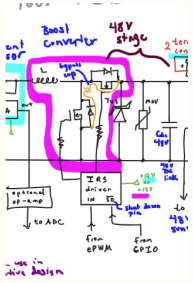
BS-C7
GRM21BR71H104KA01L

48V

Boost Stage

Takes a 24V input and converts the voltage to a 48V output by using the architecture of a boost converter. There is a gate driver to control the MOSFET switching. There is a protection scheme that follows the boost stage, and a DC link of ceramic and electrolytic capacitors are added for smoothing. Operates at a 10 kHz switching freq.





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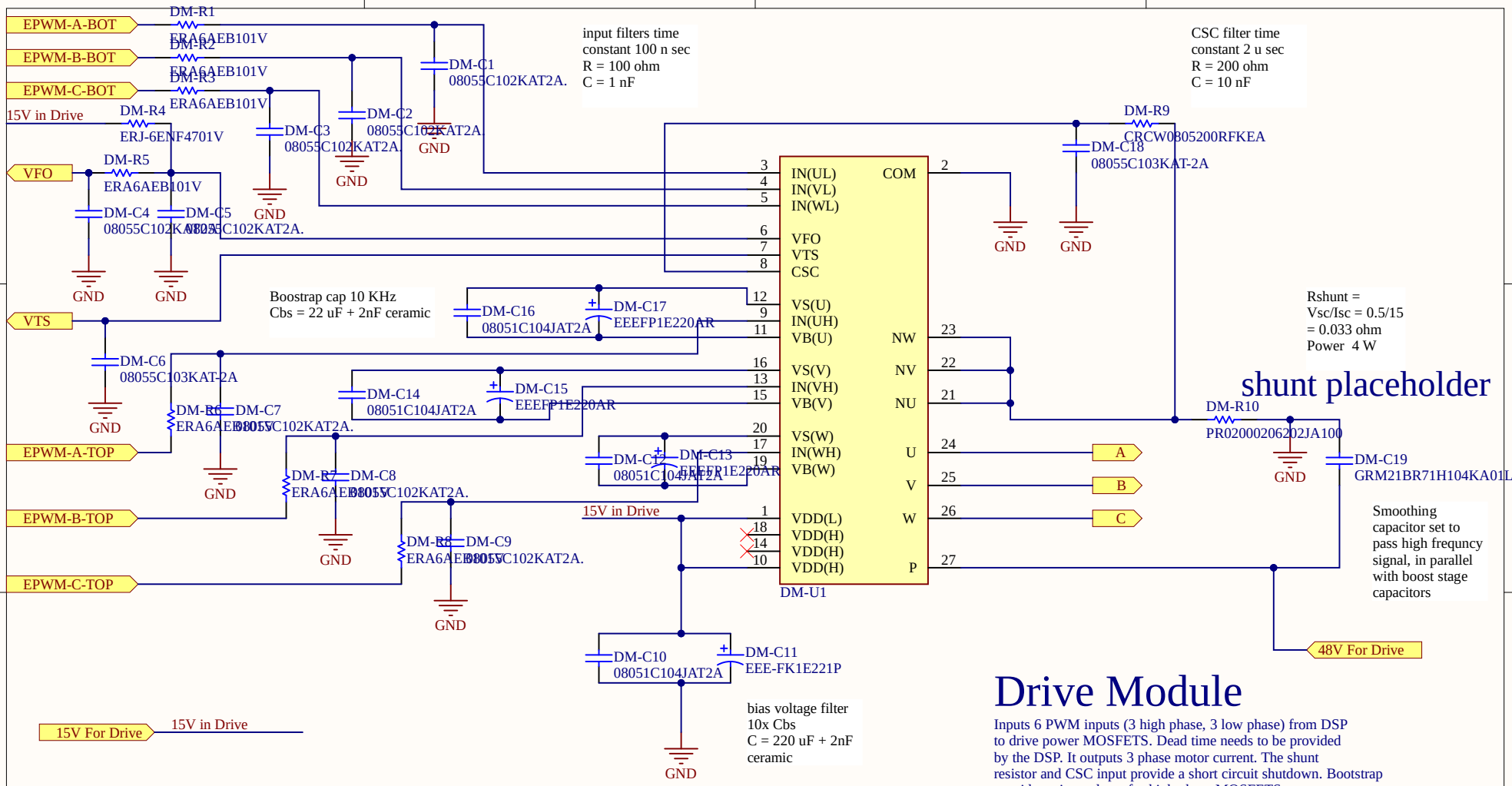
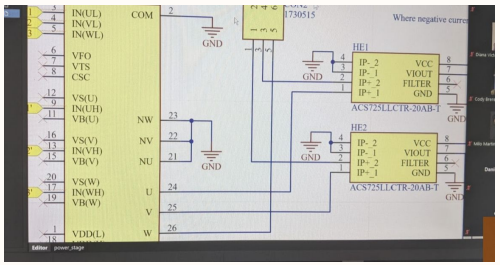
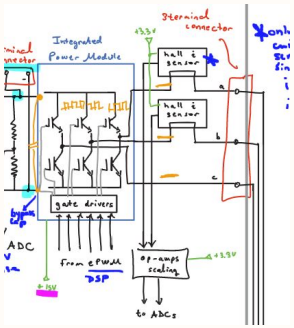


Drive Module

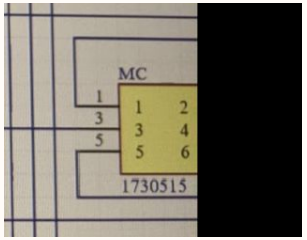
Inputs 6 PWM inputs (3 high phase, 3 low phase) from DSP to drive power MOSFETS. Dead time needs to be provided by the DSP. It outputs 3 phase motor current. The shunt resistor and CSC input provide a short circuit shutdown. Bootstrap provide gating voltage for high phase MOSFETS.

Stolen screenshot for reference





3 terminal connector 1 shorts 2, 5 shorts 6, stolen from pranavs OH



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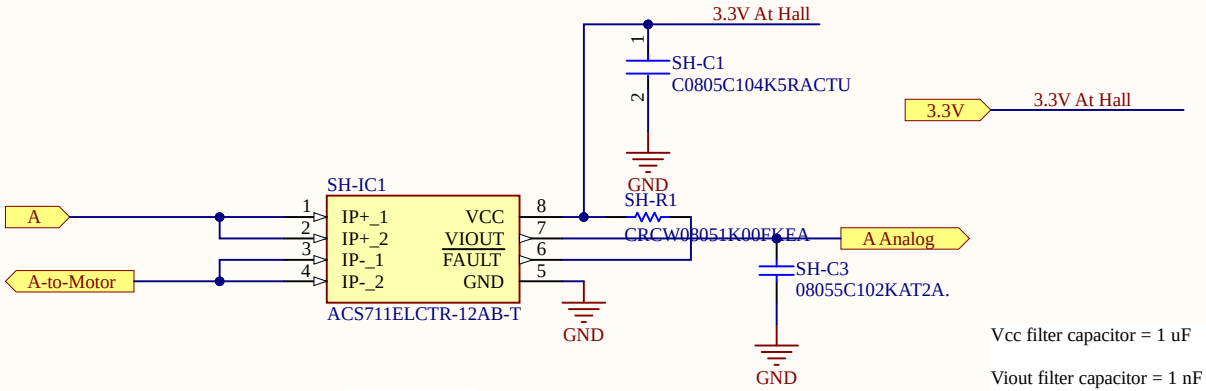
Hall Sensing

Provides motor current sensing and DSP protection for temperature sensing signals. Takes inline current and temperature signal from Motor drive circuit. Outputs 0-3.3V signal to DSP.

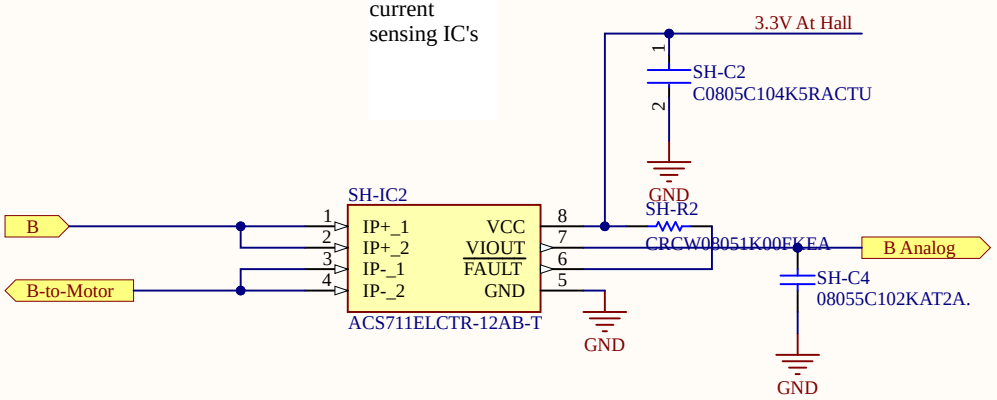


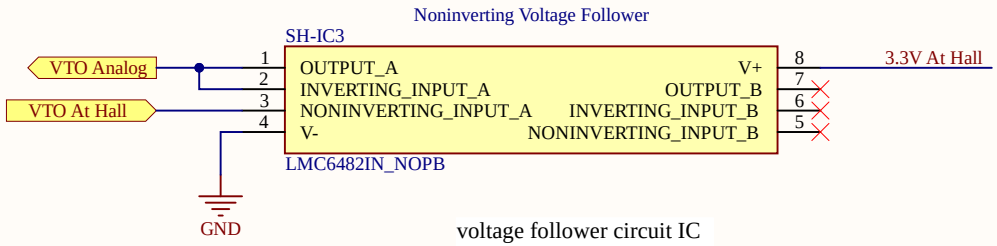
Hall effect current sensing IC's

Vcc filter capacitor = 1 uF

Viout filter capacitor = 1 nF

fault signal pull up resistor = 1 kohm





voltage follower circuit IC to protect DSP from temperature signal high voltage

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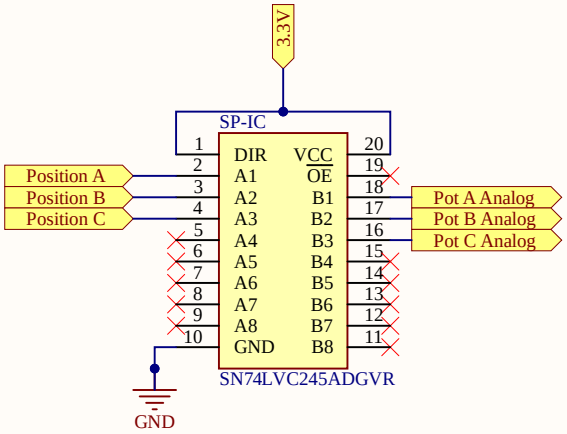
Position Sensing

Implements a level shifter IC that takes position signals from the motor hal sensors and limits the signals from 5V to 3.3V to be processed by the DSP.



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Power Supply

Takes power input from battery and provides protection and step down for ICs and motor

DC Link
C = Q/V, Q = ripple * Ts/V(dc * 1%)
i = 8.3A, Ts = 10kHz, ripple = 0.6A(7% max, assume 0.1A normal), deltaV = 0.01 * 24
C = 40uF, choose C=47uF with 0.6A rating
don't care about harmonics for input so only electrolytic is fine

24V goes to Voltage Divider

24V Series Fuse Holder (FH1)

PS-FH1
0PTF0078P

24V - No protection

protects circuit from high current

24V After Fuse

24V-To-Divider

24V-To-Current

MOV

PS-D2
EZA-EG2A50AX
Max DC Volts: 30V

TVS

PS-D1
SMBJ28A
Breakdown 31V
Clamping 45V

DC Link

47uF Electrolytic
PS-C1
EEU-FS2A470

GND

Varisistor and Transient voltage suppression to protect against high voltages

PS-PS1

24V After Fuse

GND

3.3V

GND

-VIN
+VIN
CTRL
NC_1
+VOUT
-VOUT
NC_2

3.3V Out

RS3-243.3S

PS-PS2

24V After Fuse

GND

12V

GND

-VIN
+VIN
CTRL
NC
+VOUT
-VOUT_1
-VOUT_2

12V Out

RS3-2412S

PS-PS3

24V After Fuse

GND

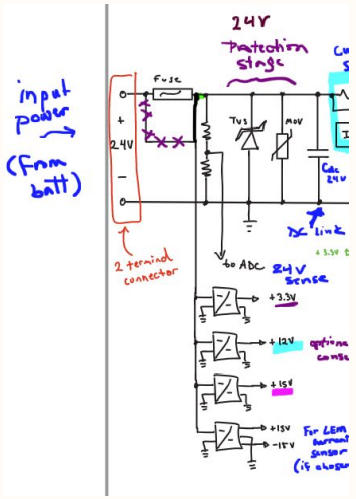
15V

GND

-VIN
+VIN
CTRL
NC_1
+VOUT
-VOUT
NC_2

15V Out

RS3-2415S



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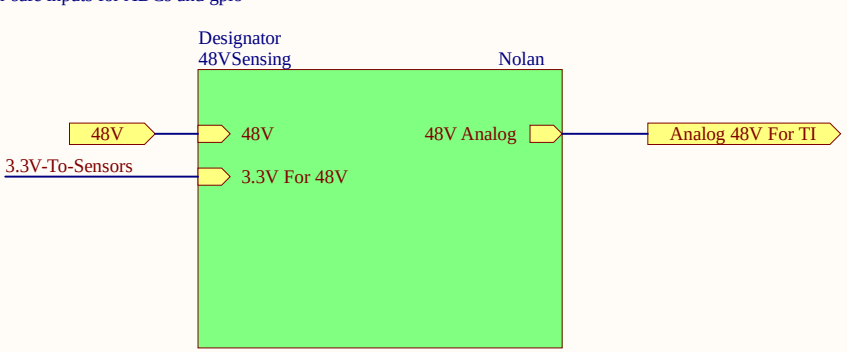
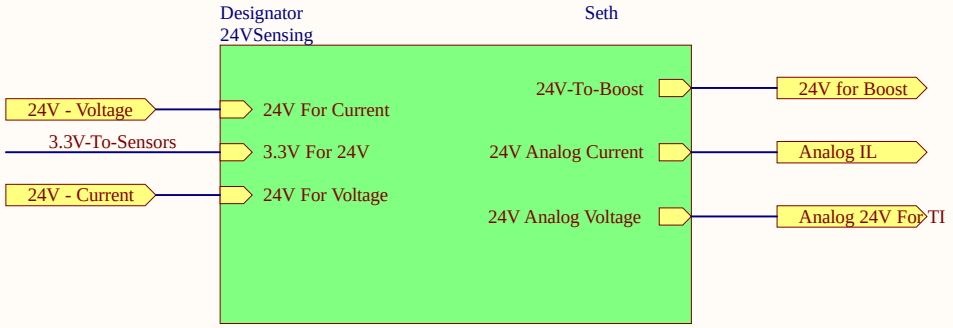
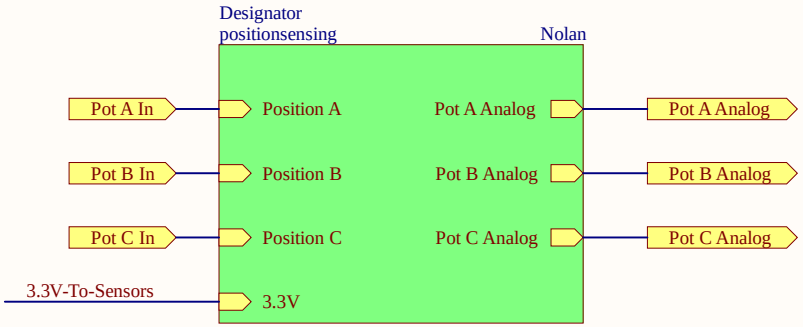
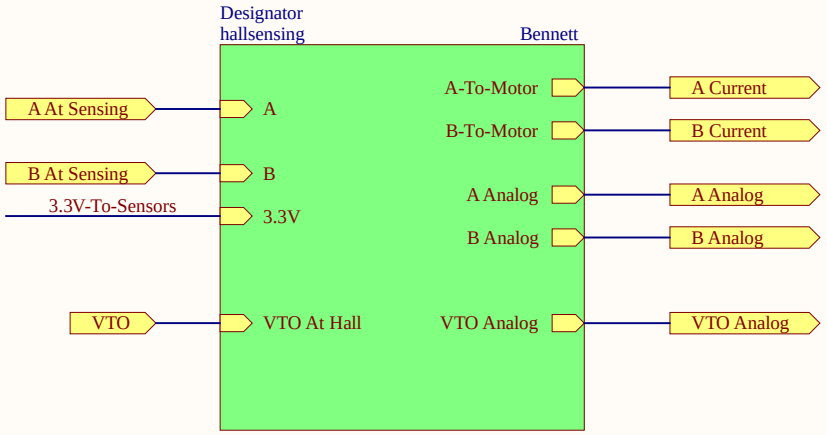
Sensing

Landing Page for all sensing ICs
for safe inputs for ADCs and gpio









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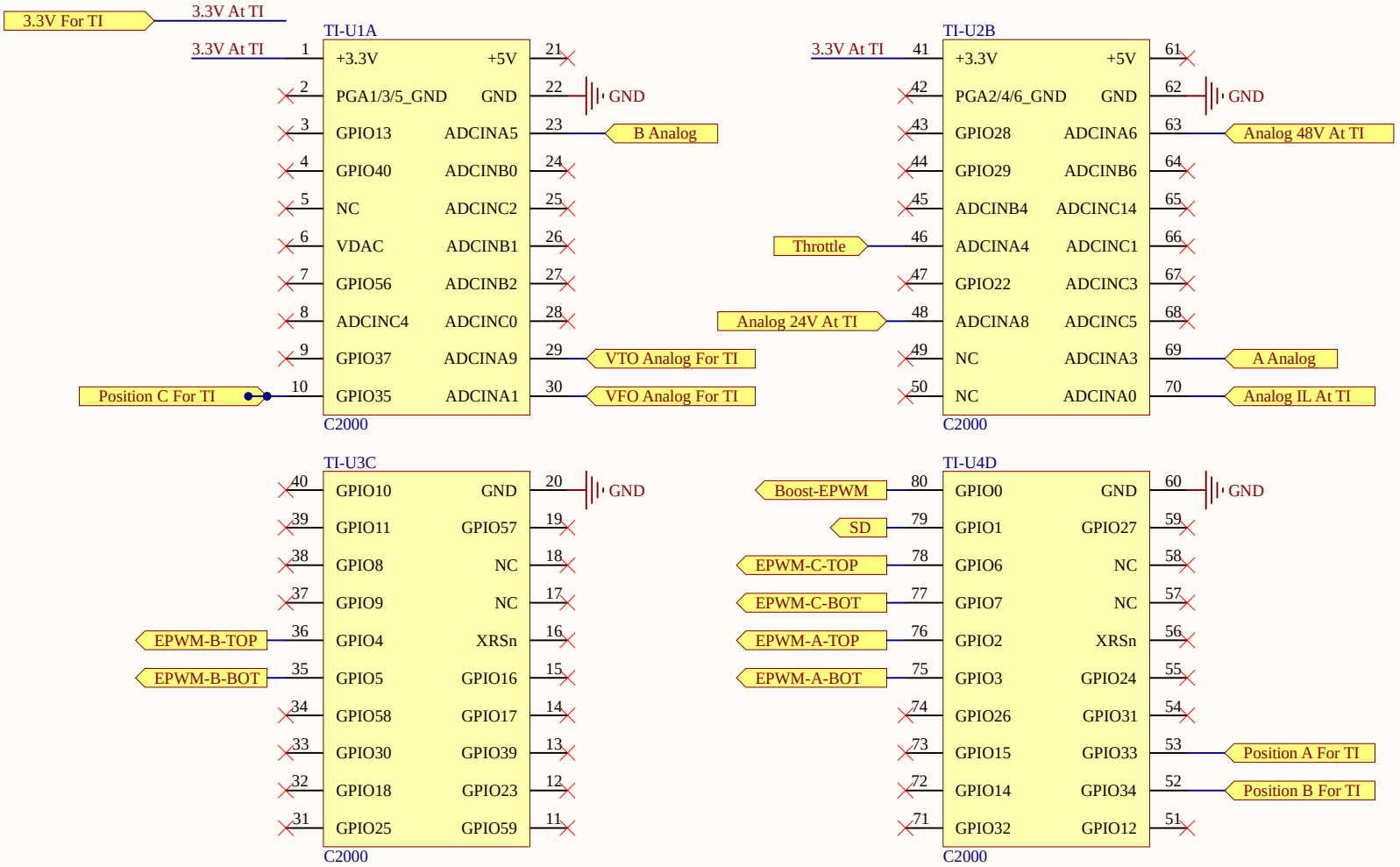
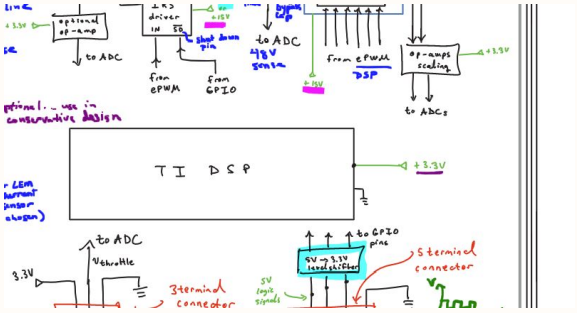
TI Launchpad

Contains all launchpad connections to the rest of the circuit





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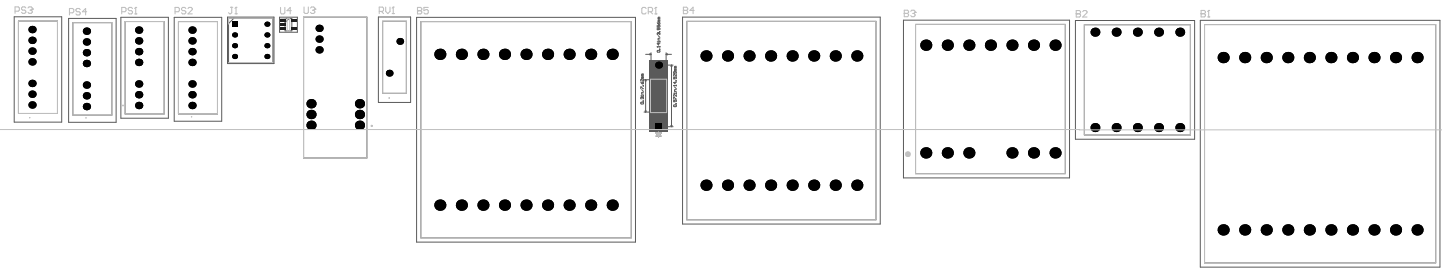
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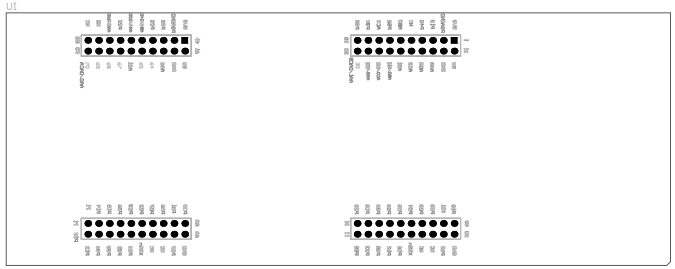
PS1
PS2
J1
U4
U3
RV1
B5
CR1
B4
B3
B2
B1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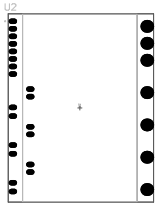
U2

Board Stack Report