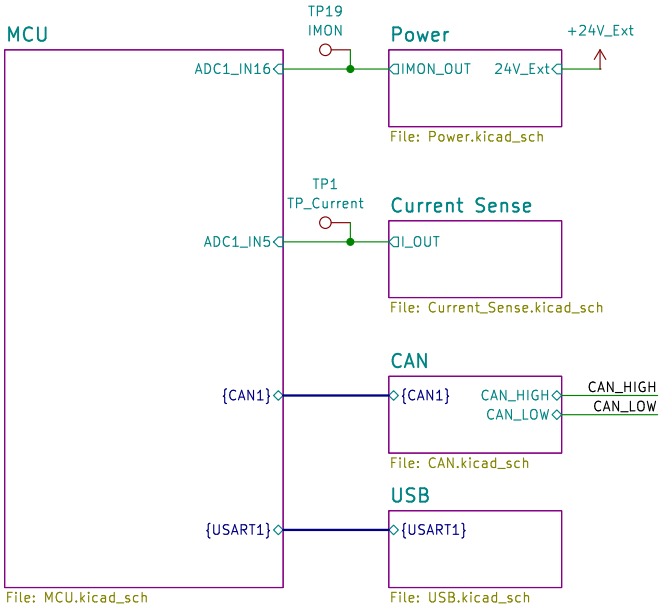

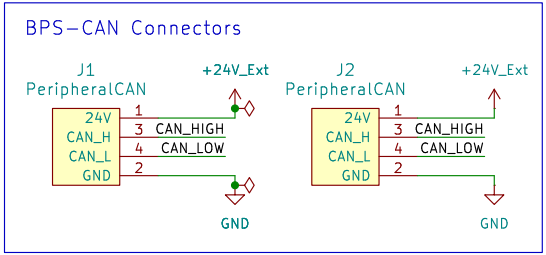

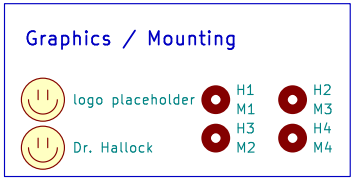

Notes

Current measuring board for battery

Battery Current Range:
* Charge (−): 32A thru Elcon; max 54A to cell
* Discharge (+): 70A
I_OUT Range: 0.45 – 3 V (for −32 to 70A range)

Max Measurable Current Range: −44 to 80A
with corresponding I_OUT Range: 0.1 – 3.2 V

Sheet: /
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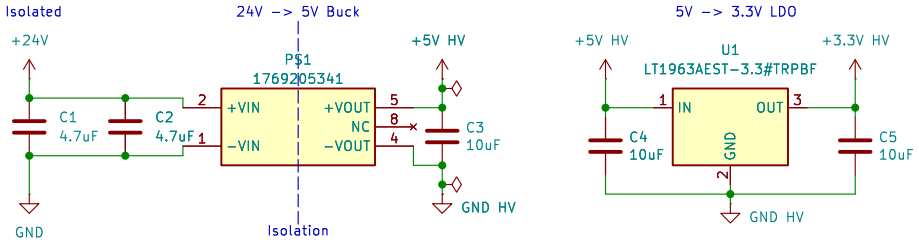
Power

3.3V: HV side

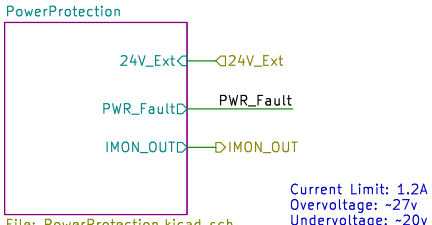
Isolated



Max Output Current: 0.2A

Power Protection

Taken from PSOM



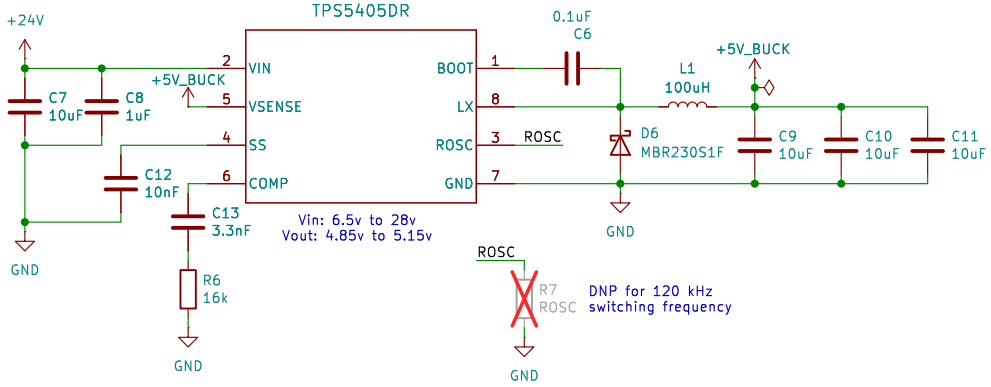
Current Limit: 1.2A
Overvoltage: ~27v
Undervoltage: ~20v
Use 1% resistors
for closest values

3.3V: LV side

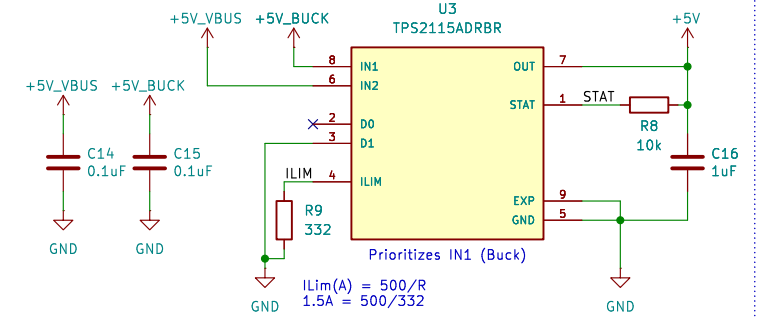
MCU, CAN

Taken from PSOM

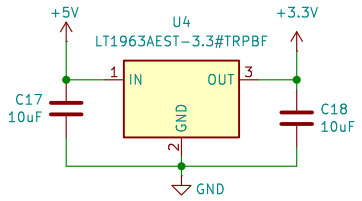
24V -> 5V Buck



5v Power Mux



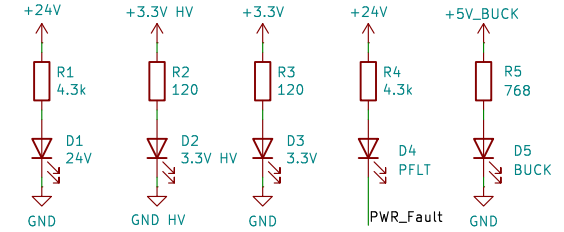
5V -> 3.3V LDO



Max Output Current: 1.5A

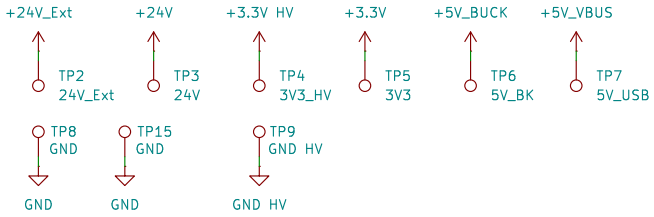
Indicators

Fault active low



5mA current

Testpoints



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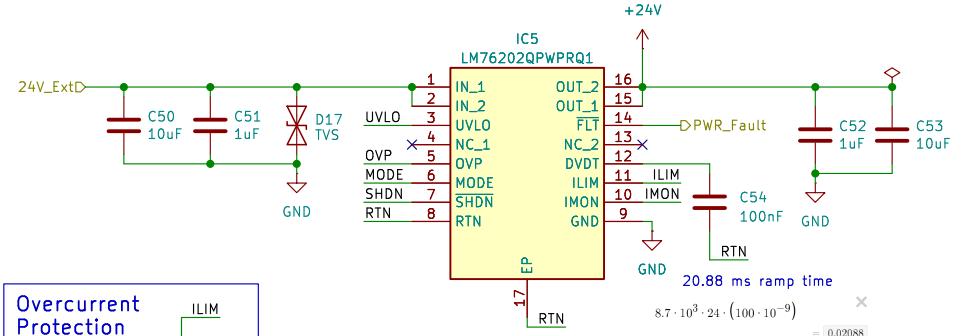
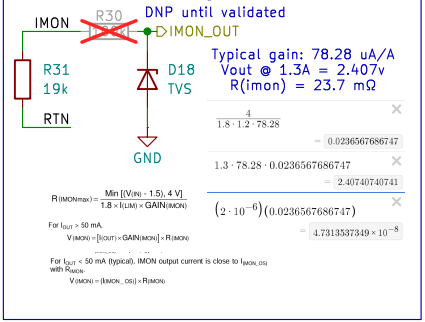
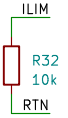


Current Monitoring

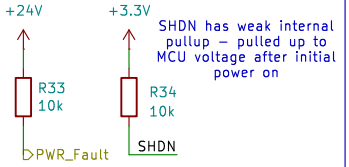


Overcurrent Protection

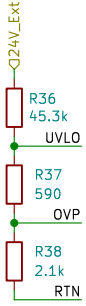
ILim(A) = 12/R(k)
1.2A = 12/10kΩ



Pullups



Under/Overvoltage Protection



	Setpoint	Ideal	Actual
UVLO	20v	1.1v	1.12v
OVP	27v	1.19v	1.18v

OVP set to 27v for buck max voltage of 28v

$$\left(\frac{2.1+0.59}{2.1+0.59+45.3}\right)20 = 1.12106688894$$

$$\left(\frac{2.1}{2.1+0.59+45.3}\right)27 = 1.18149614503$$

Functional Mode Selection

Set to circuit breaker (latchoff)

Use 0 ohm resistor for auto-retry (540ms)

Sheet: /Power/PowerProtection/
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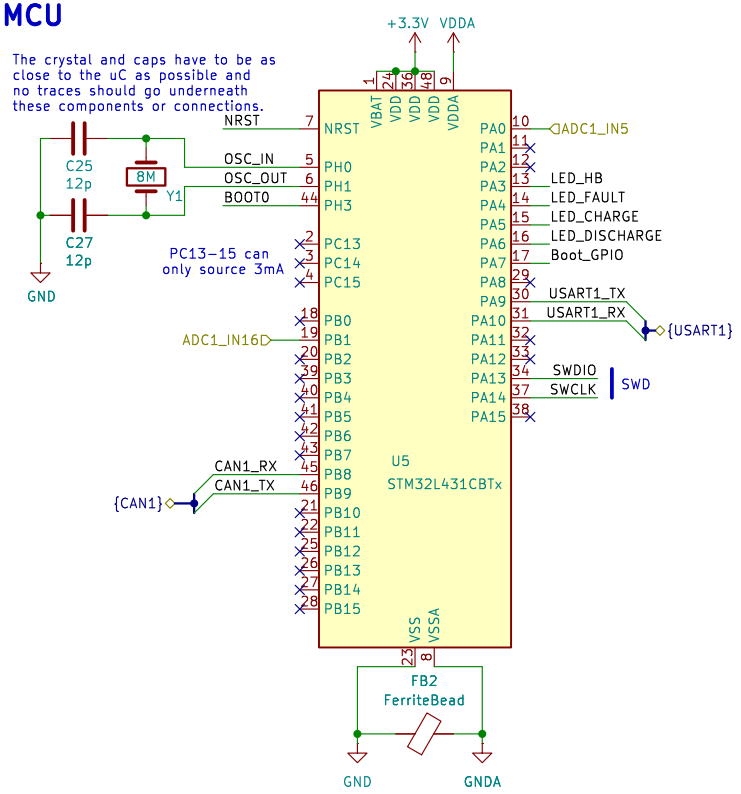
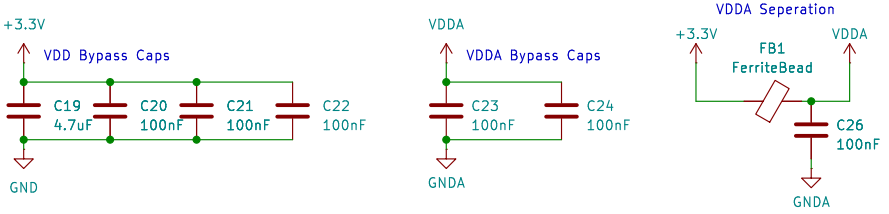
MCU

The crystal and caps have to be as close to the uC as possible and no traces should go underneath these components or connections.

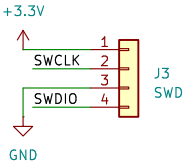


Bypass, Separation

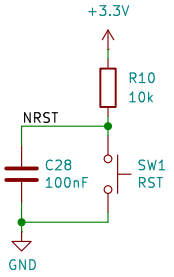


SWD Connector

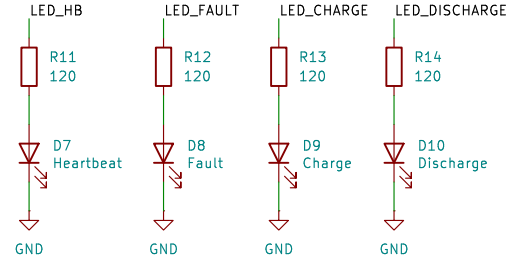
Molex Nanofit 1053091104
Mates with 0022013047



Reset Button



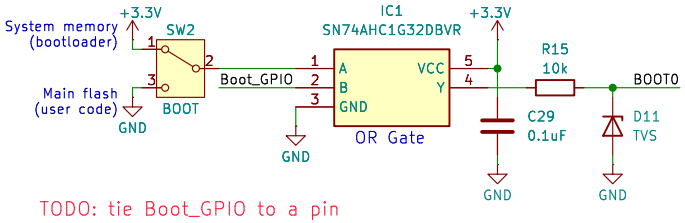
LED Indicators



USART bootloader pins (same as PSOM)

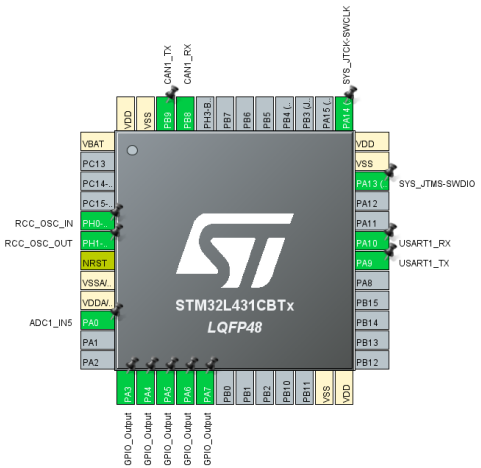
USART1_RX pin	Input	PA10 pin: USART1 in reception mode. Used in input no pull mode.
USART1_TX pin	Output	PA9 pin: USART1 in transmission mode. Used in input no pull mode.

Boot Selector



TODO: tie Boot_GPIO to a pin

Pin Functions



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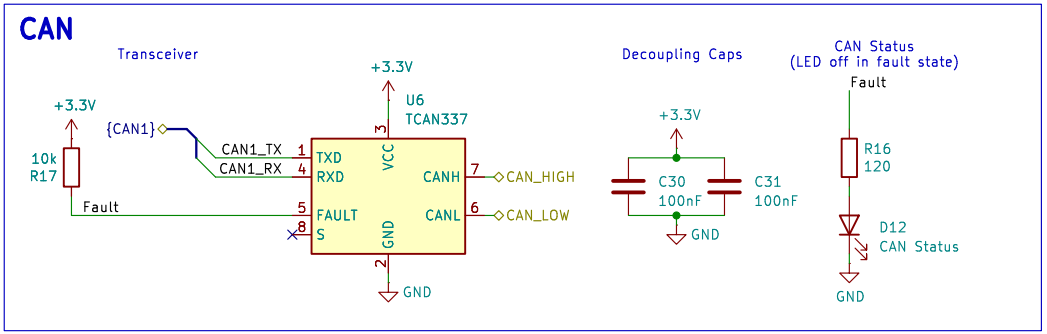
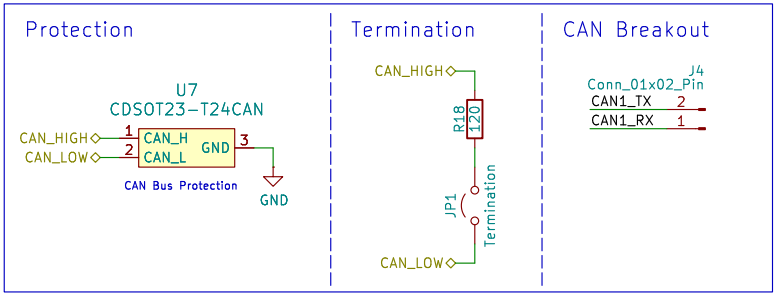
KiCad E.D.A. 9.0.5	Id: 3/7
	Rev:





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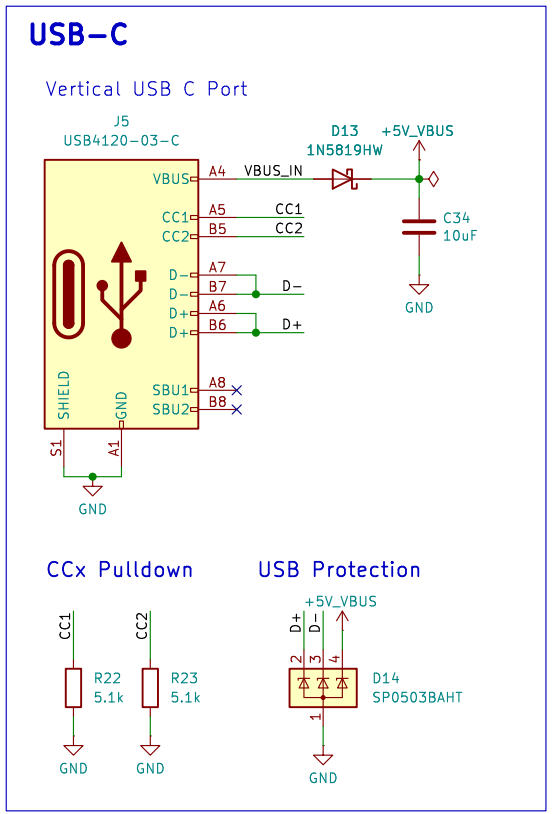
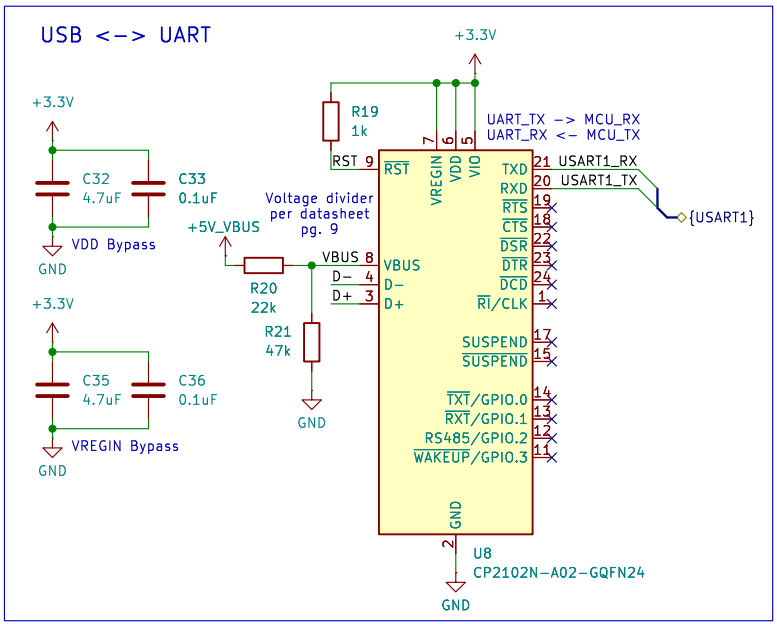
KiCad E.D.A. 9.0.5		Id: 4/7





Sheet: /USB/
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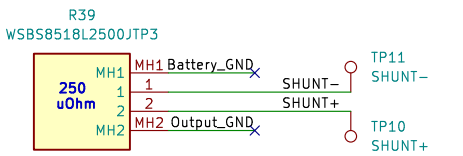
Size: A5	Date:	**Rev:**
KiCad E.D.A. 9.0.5		Id: 5/7

Current Sensing

Shunt –> current sense –> isolation –> filter

250uOhm Shunt Resistor

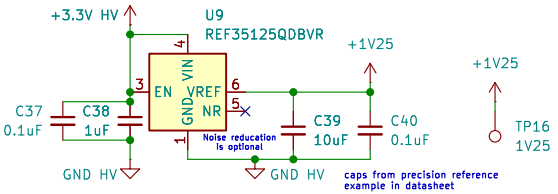


Expected current range: −32A to +70A
=> Voltage range: −8 to 17.5 mV

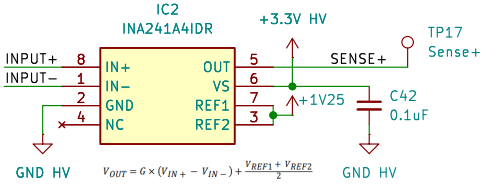
Low−Side Shunt:
* Discharge: Output_GND –> Battery_GND
* Charge: Battery_GND –> Output_GND

Footprint is M4 version; edit it to have M3 holes

Voltage Reference (1.25V)



Bidirectional current sense amp

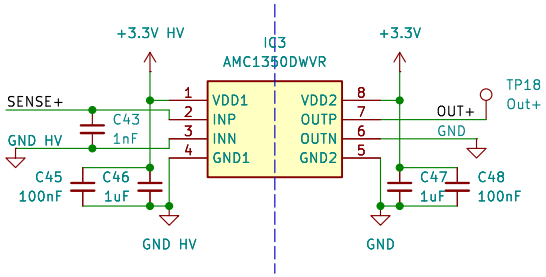


Gain: 100 V/V (INA241 A4 version)

Reference voltage (bias for discharge): 1.25V
* (70A * 250 uOhm * 100)V + Vref = 3 V
* (−32A * 250 uOhm * 100)V + Vref = 0.45 V

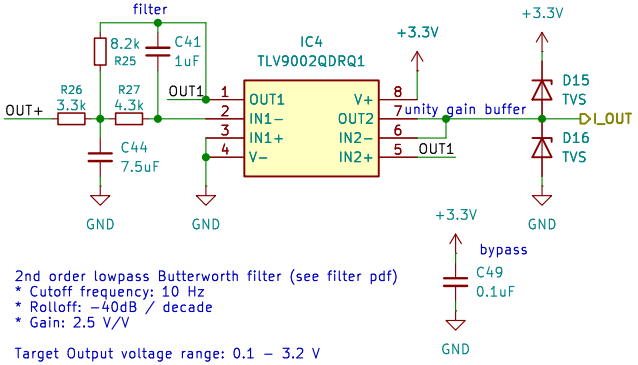
Maximum current range: −44 to +80A (0.1 to 3.2V output)

Isolation



Fixed Gain: 0.4 V/V
Target Voltage Ranges:
* Input: 0.1 – 3.2 V
* Output: 0.04 – 1.28 V

Low−Pass Filter



2nd order lowpass Butterworth filter (see filter pdf)
* Cutoff frequency: 10 Hz
* Rolloff: −40dB / decade
* Gain: 2.5 V/V

Target Output voltage range: 0.1 – 3.2 V

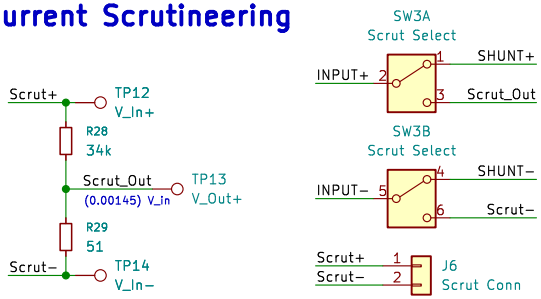
Table 8-1. R_{SENSE} Selection and Power Dissipation (1)

PARAMETER		EQUATION	RESULTS AT V_S = 5V				
			A1, B1 DEVICES	A2, B2 DEVICES	A3, B3 DEVICES	A4, B4 DEVICES	A5, B5 DEVICES
G	Gain		10V/V	20V/V	50V/V	100V/V	200V/V
V_{SENSE}	Ideal differential input voltage	$V_{SENSE} = V_{OUT} / G$	500mV	250mV	100mV	50mV	25mV
R_{SENSE}	Current sense resistor value	$R_{SENSE} = V_{SENSE} / I_{MAX}$	50mΩ	25mΩ	10mΩ	5mΩ	2.5mΩ
P_{SENSE}	Current-sense resistor power dissipation	$R_{SENSE} \times I_{MAX}^2$	5W	2.5W	1W	0.5W	0.25W

Gain: 100 V/V
Rsense = 250 uOhm
Psense = Rsense * (70A)^2 = 1.225 W

Picked shunt first, then adjusted gain to meet ADC range
If additional gain is needed, tweak filter circuit

Current Scrutineering



Scrutineering:
– Pass in voltage from scrutineering board
– Use switch to select between shunt / scrutineering inputs

Expected Voltage Input: +– 12V
Scrutineering Output: +– 18 mV

Sheet: /Current Sense/
File: Current_Sense.kicad_sch

Title:

Size: A4 | Date: | **Rev:**
KiCad E.D.A. 9.0.5 | Id: 6/7