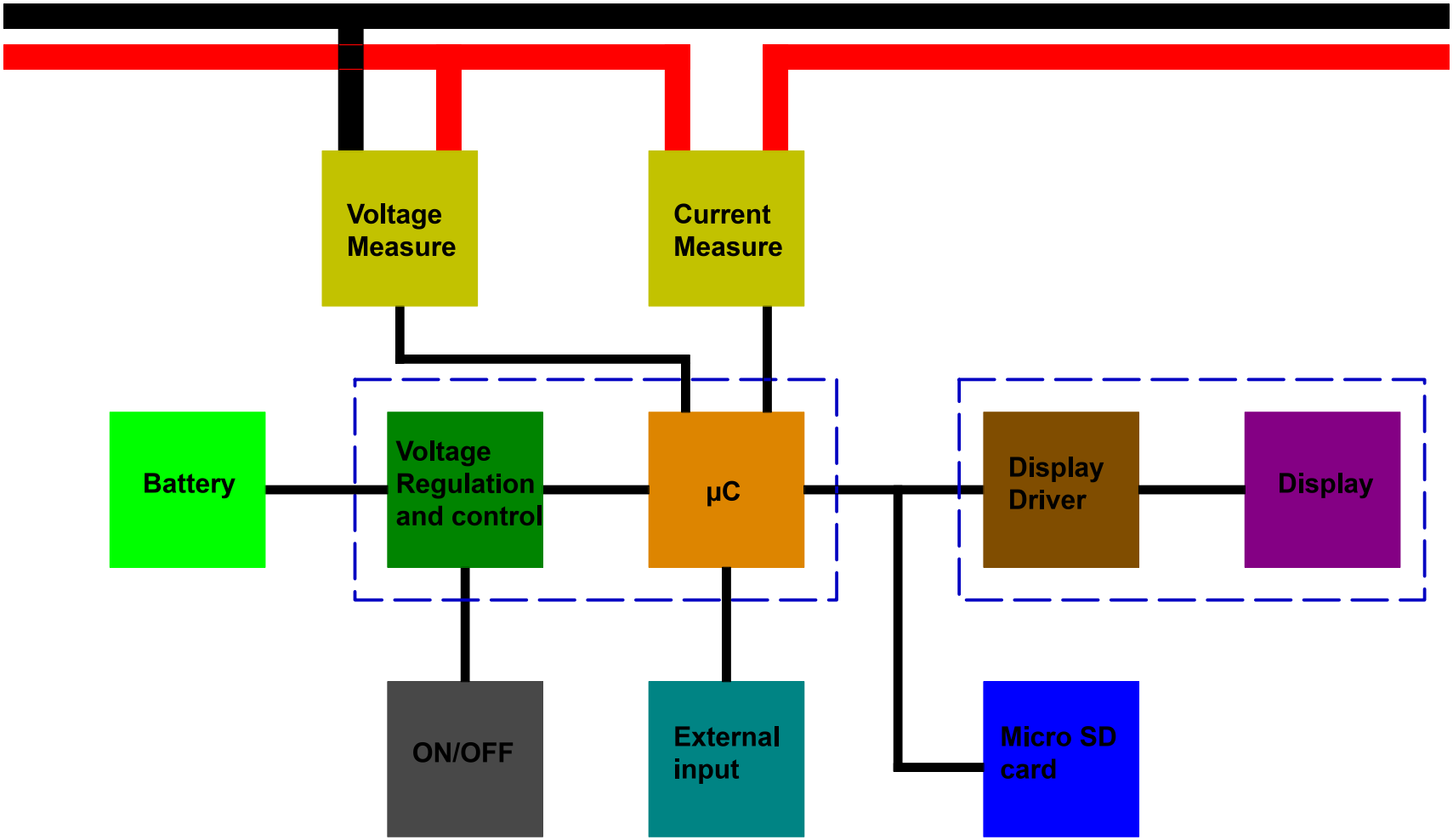


Joulemeter block diagram

Designed by Anthony Ng
Imperial College London Shell Eco Marathon 23–24

Sheet: /
File: Joulemeter v1.kicad_sch

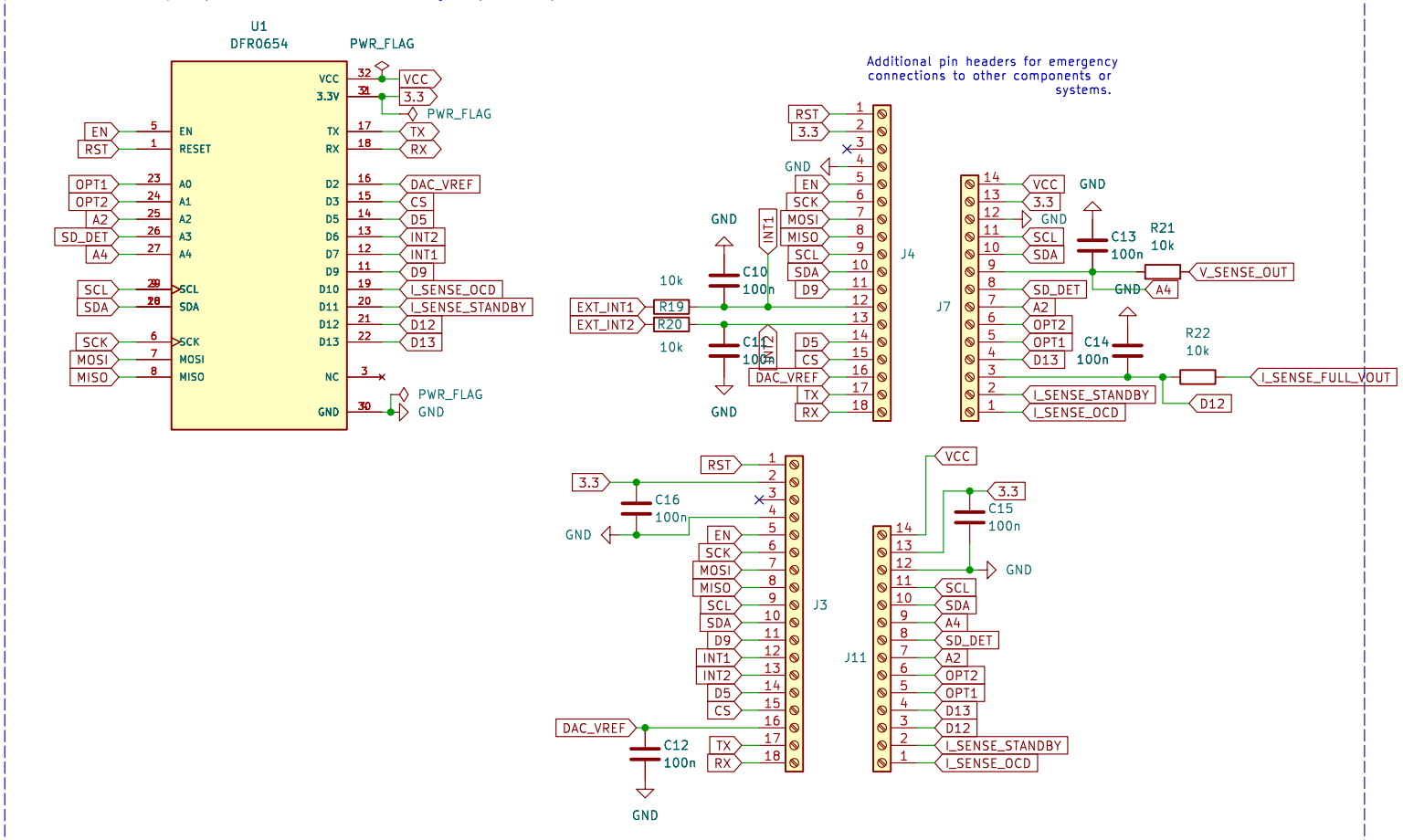
Title: Joulemeter

Size: A4	Date: 2023-11-05	**Rev: 1.5**
KiCad E.D.A. 8.0.0		Id: 1/6

Consult datasheet for pin layout.

Power flags only necessary for ERC validation

Microcontroller – ESP32E



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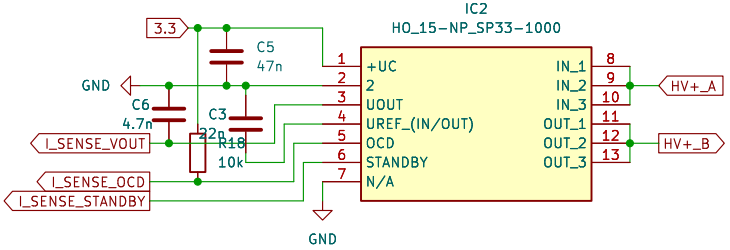
Sheet: /Microcontroller/

File: Joulemeter_Microcontroller.kicad_sch

Title: Joulemeter

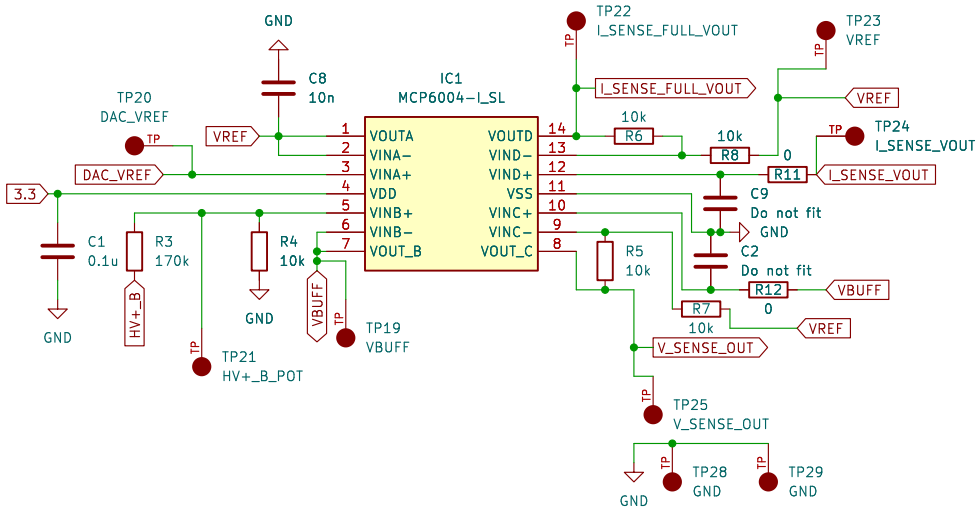
Size: A4	Date: 2023-11-05	**Rev: 1.5**
KiCad E.D.A. 8.0.0		Id: 2/6

Current Measurement



HO 15-NP/SP33-1000 is a current transducer that uses an internal hall effect sensor to provide an output voltage proportional to the applied current. The installed capacitors are recommeneded by the manufacturer. This is the same hall-effect current snesor used in the motor controller schematic. Symbol not as fancy.

Voltage Measure & I_SENSE_VOUT correction



Voltage measure: use voltage divider and pass through buffer. Then stretch output voltage to use full swing of amplifier.
Current measure: use I_SENSE_OUT from IC2 and stretch output to use full swing of amplifier.

Both systems have a non-inverting opamp with inverting positive reference voltage, for detail see the TI application paper.

C1 must be placed close to IC1 and via into the ground plane.

Resistors: all not finalised values, only placeholders. Perform additional claculations and LTspice simulations to determine the most suitable values here. For initial configuration install R11, R12 as short circuits or as 0Ω resistors. Filters may be required for these signals if ADC observes noisy measurements.

Opamp A is used for DAC reference voltage buffering. Input custom in reference voltage to be used for output swing extension.

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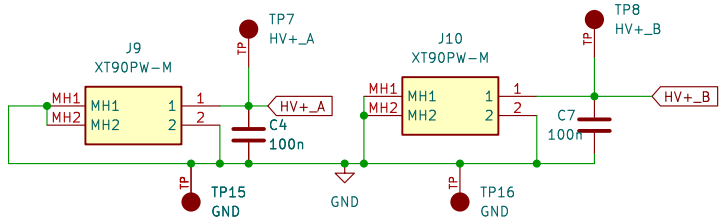
Sheet: /Line Measurements/
File: Joulemeter_Line Measurements.kicad_sch

Title: Joulemeter

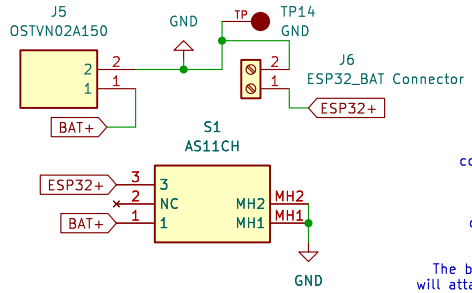
Size: A4	Date: 2023-11-05	**Rev: 1.5**
KiCad E.D.A. 8.0.0		Id: 3/6

High Voltage to PCB Interface



Two XT90 connectors will interface with joulemeter PCB with the vehicle electrical system. HV+ is designated for 30-56V line and the HV- designated for the vehicle electrical system ground. The mounting holes, MHn, are two be grounded.

ON/OFF Battery slide switch



A slide switch will be mounted to the PCB to allow ON/OFF control for the joulemeter.

A LiPo pouch cell will be used to supply power to the joulemeter, running independently from the vehicle electrical system. The plan is to cut the wires from the battery and the plastic plug. The end with the plastic plug will connect to the corresponding plug on the ESP32 board. The wires attached to this plug will be soldered to the PCB through holes emulated by J6, with an electrolytic capacitor footprint. Pay close attention to the wire polarity when installing.

The battery cell and its corresponding wires will attach to the screw terminals at J5. Once again, the polarity is important because we don't want damage to the ESP32 or get "very decorative smoke".

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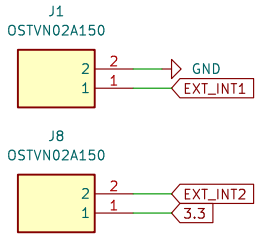
Sheet: /Power Circuitry/
File: Joulemeter_PWR_Circuit.kicad_sch

Title: Joulemeter

Size: A4	Date: 2023-11-05	**Rev: 1.5**
KiCad E.D.A. 8.0.0		Id: 4/6

External Interrupt for Distance determining Hall effect Sensor



Use 2.54 mm screw terminal block to connect an external hall effect sensor attached to rear wheel. It will provide an interrupt so the distance travelled by the vehicle can be determined and the distance travelled per kilowatt hour.

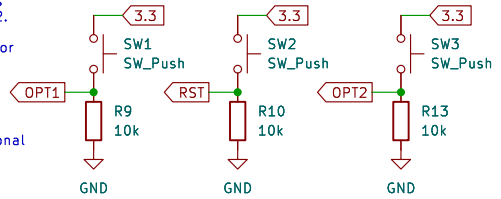
RESET Push button

Uses pull-down resistors with external push button.

Assumes RESET requires high to reset the ESP32.

Use electrolytic capacitor footprint for push button as wires will connect PCB to push buttons.

Include pads for additional push button for extra functionality later.



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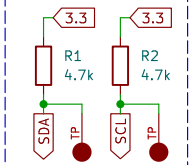
Sheet: /External Inputs/

File: Joulemeter_EXT_inputs.kicad_sch

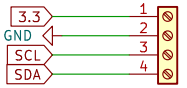
Title: Joulemeter

Size: A4	Date: 2023-11-05	**Rev: 1.5**
KiCad E.D.A. 8.0.0		Id: 5/6

I2C Pullup

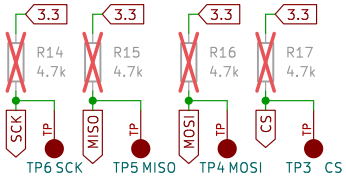


LCD1602 Display Interface



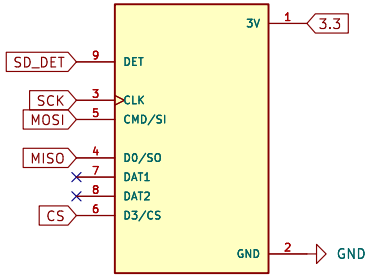
To use LCD display, connect four wires into the 1x4 pin header holes in PCB. No screw terminal will be used; this is a place-holder connector.

SPI Pullup*



Generally SPI doesn't need pullup but the datasheet is not that informative about the schematic for the SD module. Have pads and populate later if needed. CS may need one since it is a standard digitally configured GPIO connector.

Micro SD card to SPI/SPIO



For SPI connections,use 3V, GND, CLK, SO, SI, CS and DET. All other connections are used for SPIO logic, which we are not using.

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Sheet: /Local Communications/

File: Joulemeter_LocalCommunications.kicad_sch

Title: Joulemeter

Size: A4	Date: 2023-11-05	**Rev: 1.5**
KiCad E.D.A. 8.0.0		Id: 6/6