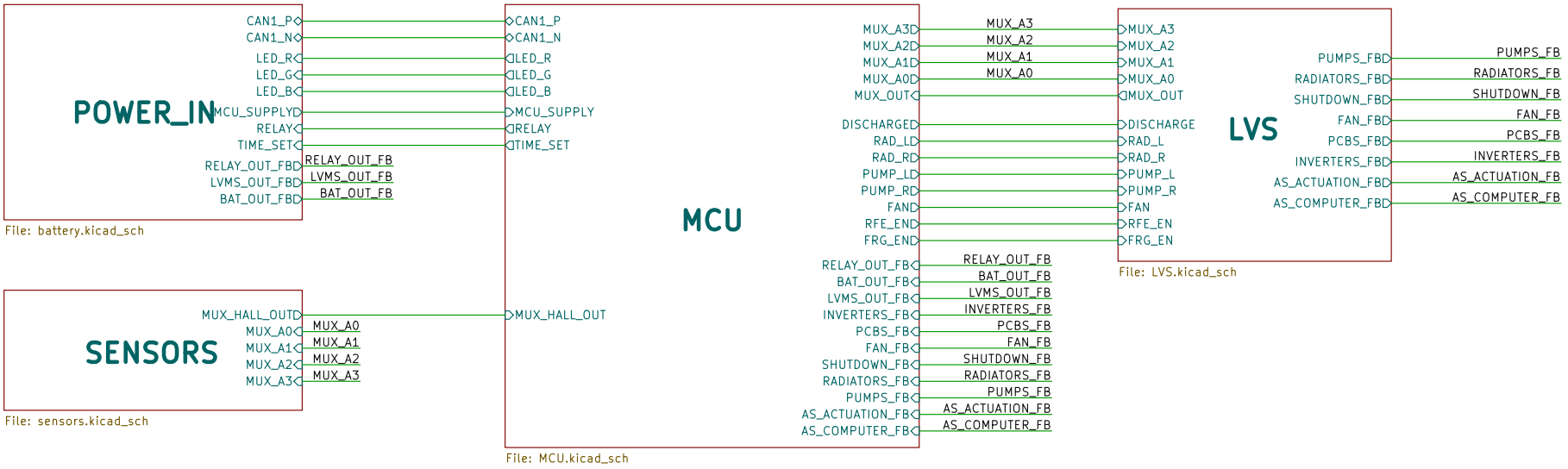


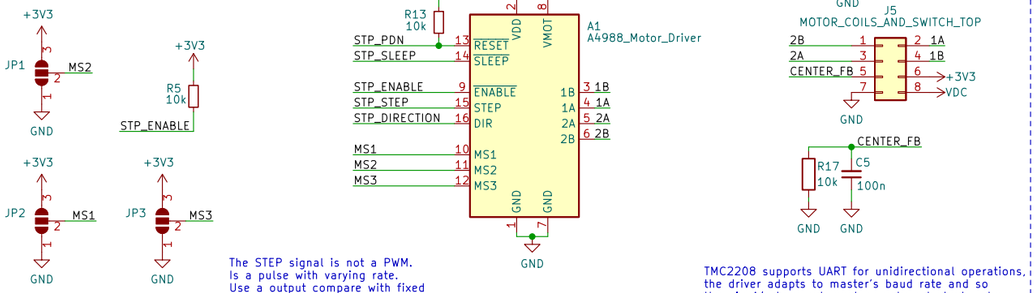
Mirco Tollardo
Nicolò Durisotto
E-Agle TRT

Sheet: /
File: fenice-bms-lv-hw.kicad_sch

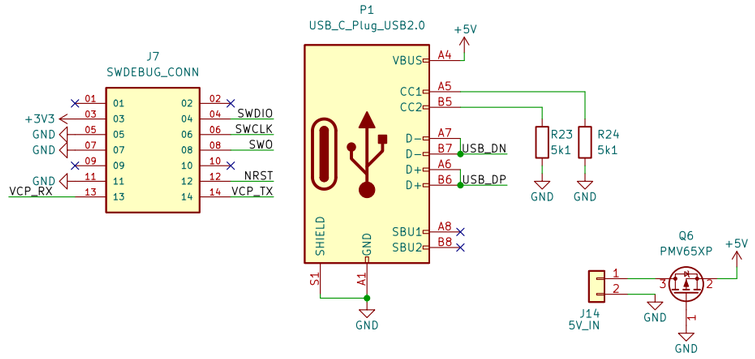
Title: Fenice BMS LV

Size: A4	Date: 2021-10-12	**Rev: 1.1**
KiCad E.D.A. eeschema (6.0.2-0)		Id: 1/5

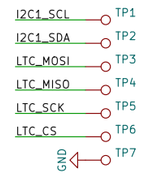
MOTOR DRIVER A4988



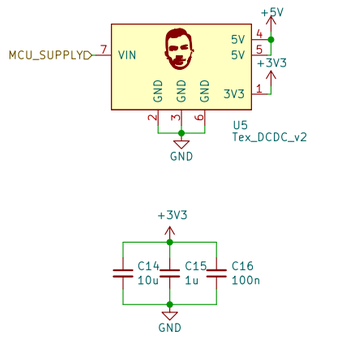
DEBUG CONNECTORS



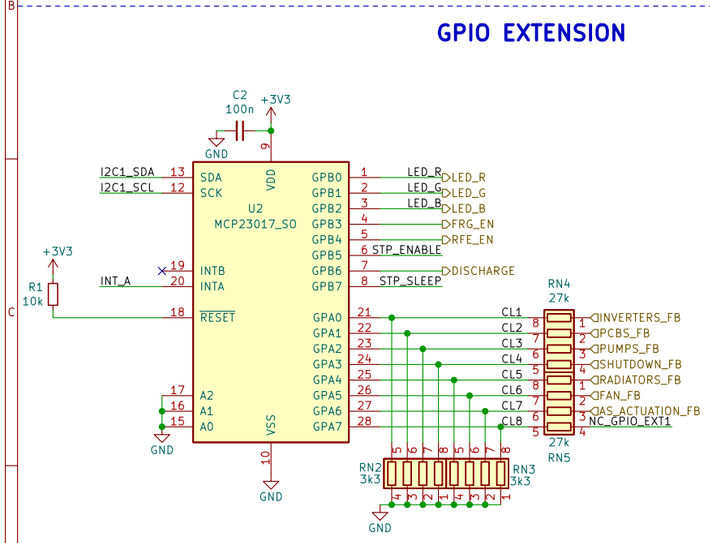
TESTPOINT

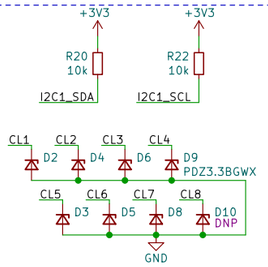


MCU POWER SUPPLY

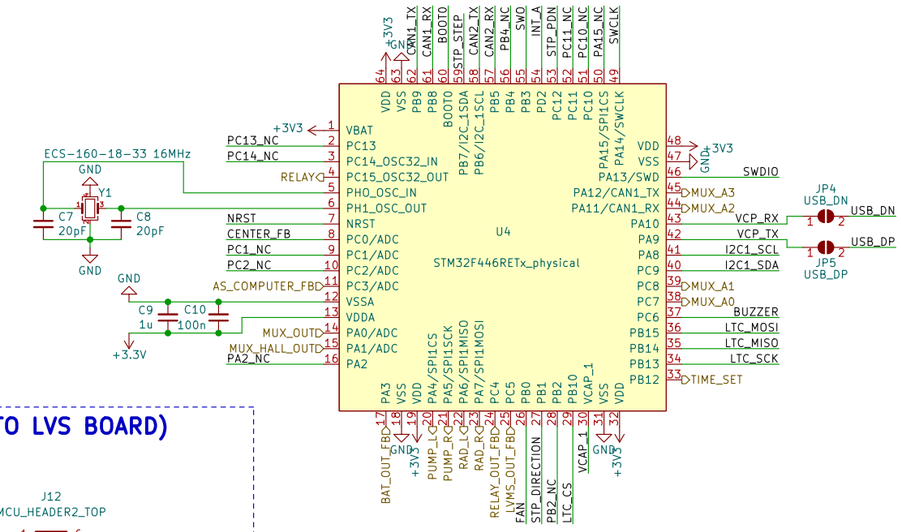


GPIO EXTENSION

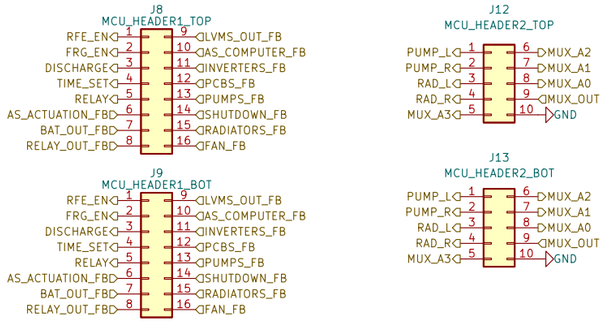




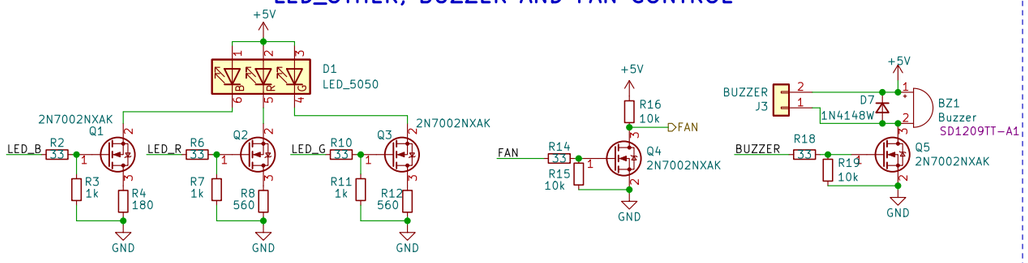
MCU



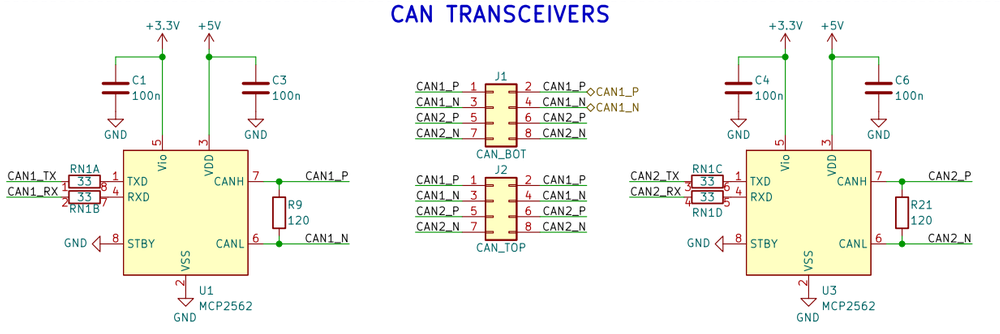
TOP TO BOTTOM HEADERS (MCU TO LVS BOARD)



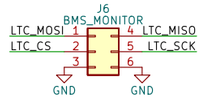
LED_OTHER, BUZZER AND FAN CONTROL



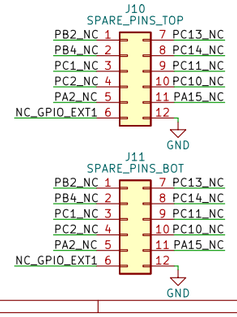
CAN TRANSCEIVERS

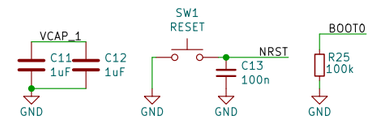


CELLBOARD



SPARE PINS





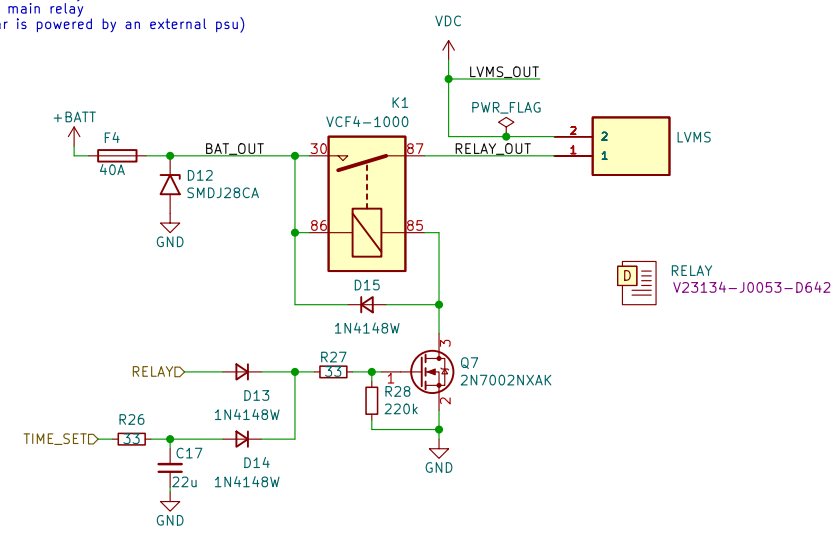
Mirco Tollardo
Nicolò Durisotto
E-Agle TRT

Sheet: /MCU/		
File: MCU.kicad_sch		
Title: Fenice BMS LV		
Size: A3	Date: 2021-10-12	**Rev: 1.1**
KiCad E.D.A. eeschema (6.0.2-0)		Id: 3/5

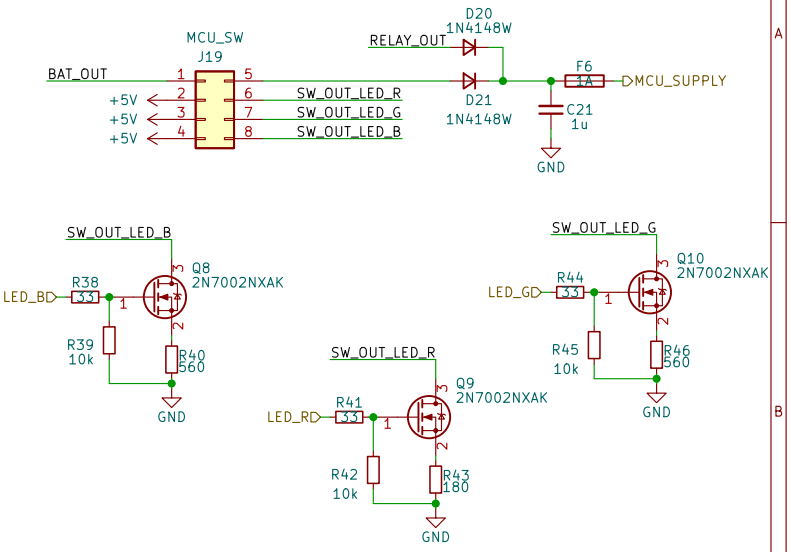
LVMS & BMS RELAY

A note for SW:
if voltage at RELAY_OUT outside battery's
rated voltage, DO NOT close main relay
(this might happen if the car is powered by an external psu)

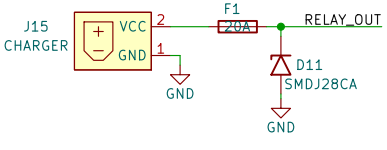
BAT_OUT_FB will also serve as feedback in order to add a self-kill switch for the MCU.
As stated in FSG rules, the LVMS must disable the whole LVS.

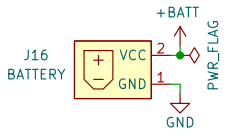


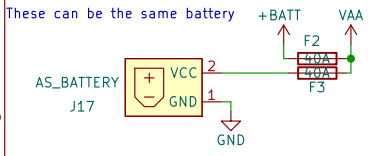
MCU SWITCH



CHARGER & BATTERY CONNECTORS

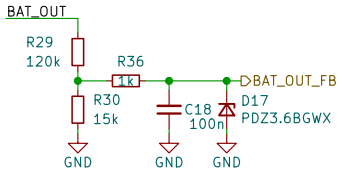


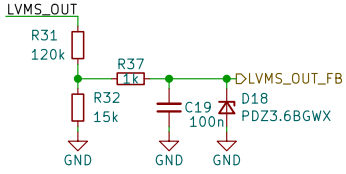


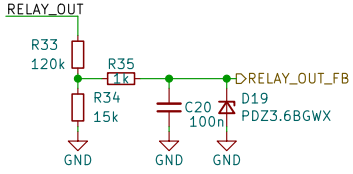


A 40A fuse can be used as a jumper.
If a single battery pack is used it is
necessary to fit in the fuse to use the AS

ANALOG VOLTAGES READING



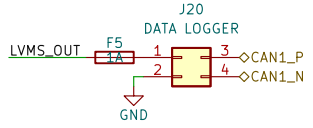




For 28V the output voltage will be 3,11V

DATALOGGER

As stated in the 2022 FSG datalogger's datasheet:
The DL must be supplied by a voltage of 12 V DC to 60 V DC.
It draws a maximum power of 10 W.
It must be reasonably fused in the supply wiring.



EV 4.6.6
The datalogger must be directly supplied from the LVMS

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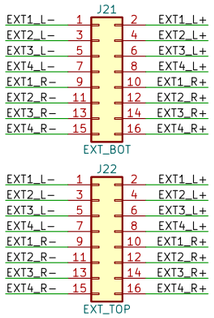
Nicolò Durisotto
E-Agle TRT

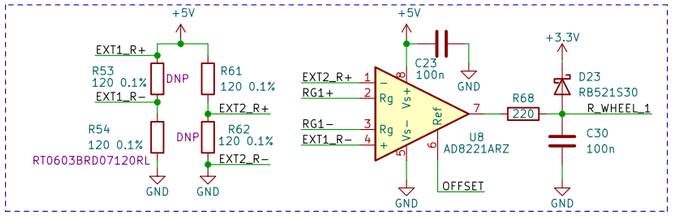
Sheet: /POWER_IN/
File: battery.kicad_sch

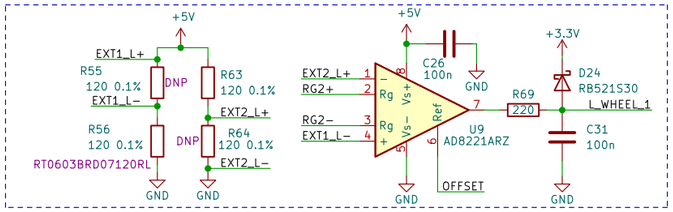
Title: Fenice BMS LV

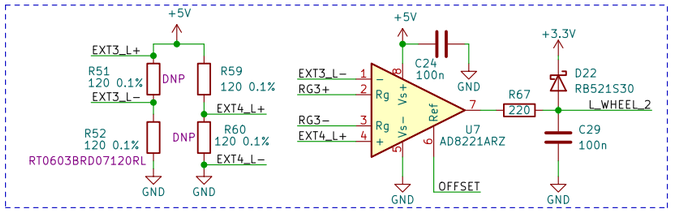
Size: A4	Date: 2021-10-12	**Rev: 1.1**
KiCad E.D.A.	eeschema (6.0.2-0)	Id: 5/5

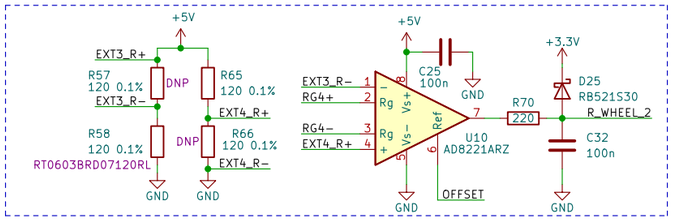
STRAIN GAUGES CONDITIONING



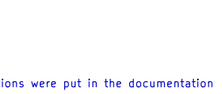








To determine opamp gain through Rg resistance:
G = 1 + (49400/Rg)
For G = 1.3, R = 164000 ohm
R = 150k will be chosen (G = 1.33)



Due to opamp's output and input swing the maximum voltage range for 3,3V is between 1,9 and 2,2V
For 5V is between 1,9V and 3,9 for input signals.
For this reason a voltage offset of 2.5V will be used.

As stated in AD8221's datasheet Vref has to be driven by a low impedance voltage source.
This can be confirmed by looking at the internal circuit diagram, an impedance on that input will affect the gain.
A voltage reference will then be used:

Also compatible with
LT1460 abd most voltage references with a SOT-23 package

Maximum voltage difference on Wheatstone bridge calculated knowing:

Maximum strain range = 10% (depends on the strain gauge type)
Reference resistance = 120 ohm
Maximum extension resistance = 132
Maximum compression resistance = 108
Amplifier gain = 1.33

Calculations at maximum extension:

V− = (5*120)/(120+132) = 2.38V
V+ = (5*132)/(120+132) = 2.62V

V+*G − V−*G = 0.32V

Calculations at maximum compression:

V− = (5*120)/(120+108) = 2.63V
V+ = (5*108)/(120+108) = 2.37V

V+*G − V−*G = −0.34V

With an offset of 2.5V:

2.18 < Vout < 2.79V

Tha gauge factor is calculated as follows considering the characteristics of the reference strain gauge (maximum length difference is 10% of standard length and 120 ohm resistance):

$$GF = \frac{\Delta R}{R * \varepsilon\ (\text{applied strain})} = 11$$

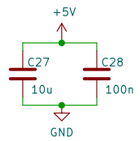
The gauge factor defines how much resistance changes in proportion to applied strain ε. To calculate the extension/compression:

$$\varepsilon = \frac{\Delta l}{l}$$

$$\varepsilon = \frac{\Delta R}{R * GF}$$

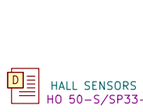
Further calculations were put in the documentation

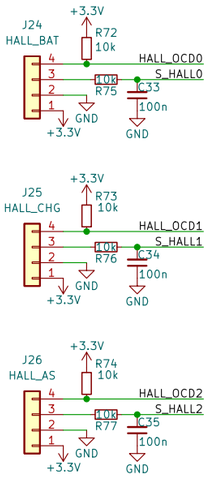
5V FILTER



One sensor will measure otput current from the batteries
One will be used to monitor the current from the charger

HALL CURRENT SENSORS





For the current sensor:

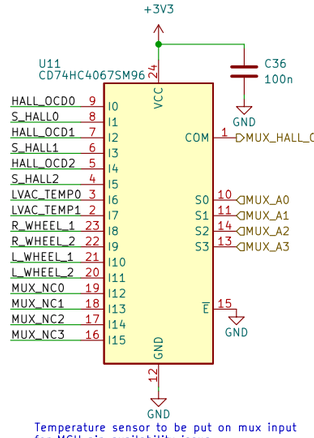
Vref = 1.65V
Theoretical Sensitivity = 1.84 mV/A

Vout = Vref+Current*Sensitivity

Current = (Vout − Vref)/Sensitivity

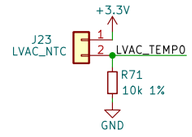
OCD is low when the current flowing the current transducer is 2.92*Ipn
Ipn is the primary nominal current, which in this case is 50A

This can just be used during tests to determine average current going through the AS

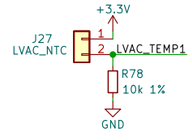


Temperature sensor to be put on mux input for MCU pin availability issue

LVAC TEMPERATURE SENSORS



NTC Battery temperature sensor 10k



This can connector can be attached to an NTC or alternatively to another sensor that can be addded later.

MUX_NC0
MUX_NC1
MUX_NC2
MUX_NC3

Cutoff Frequency for LPFs:

1/(2*pi*220*10^(−7)) = 7234 Hz

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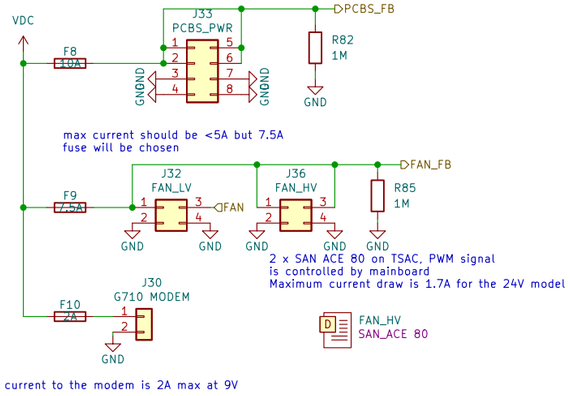
Nicolò Durisotto
E-Agle TRT

Sheet: /SENSORS/
File: sensors.kicad_sch

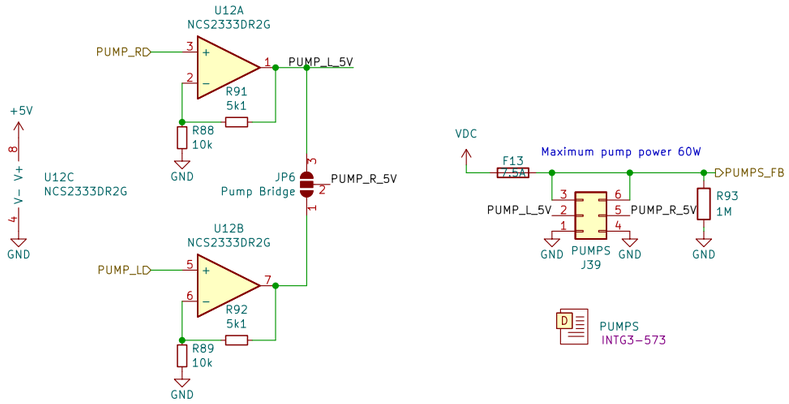
Title: Fenice BMS LV

Size: A3	Date: 2021-10-12	**Rev: 1.1**
KiCad E.D.A. eeschema (6.0.2-0)		Id: 6/5

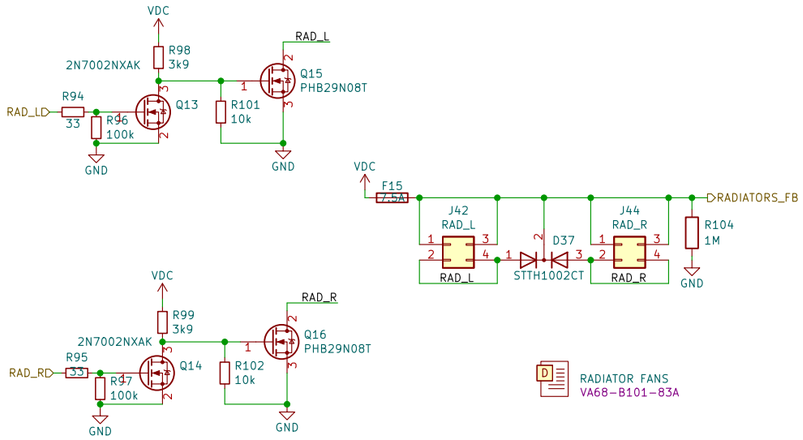
LVS CONNECTORS



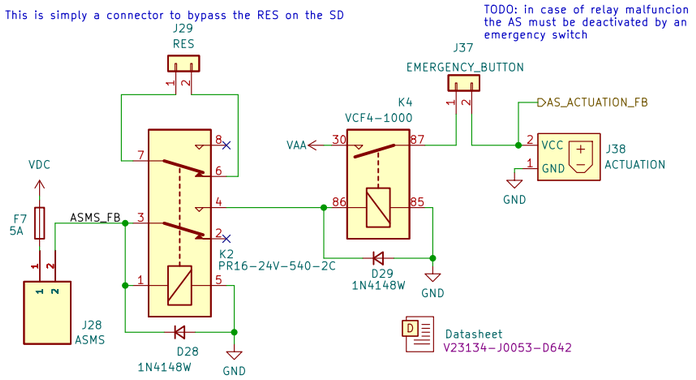
PUMPS



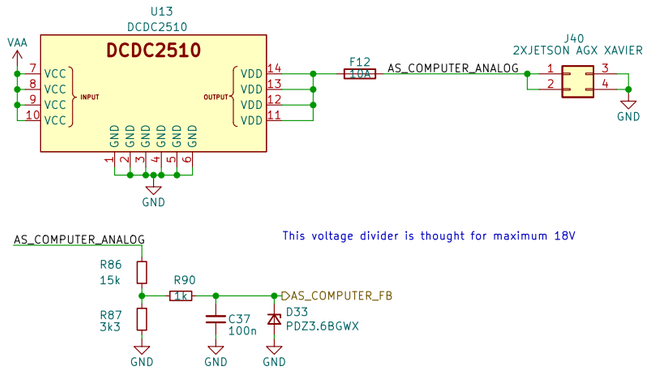
RADIATORS



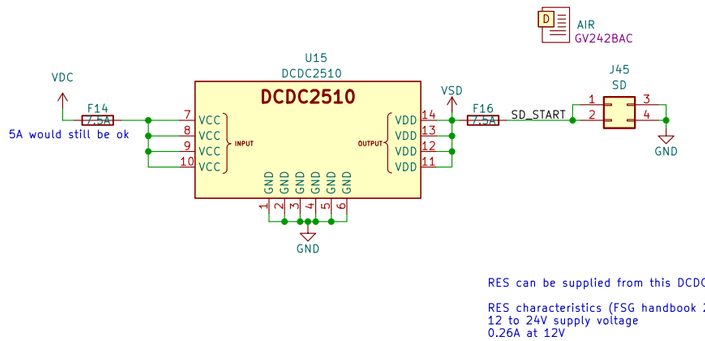
AUTONOMOUS DRIVE ENABLE



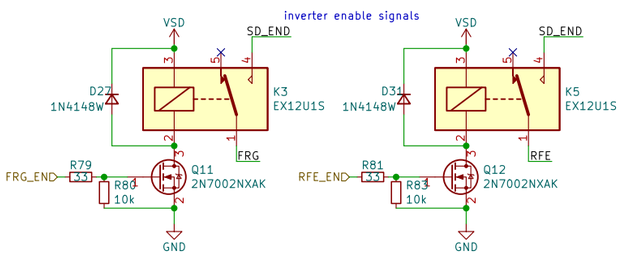
JETSON DCDC

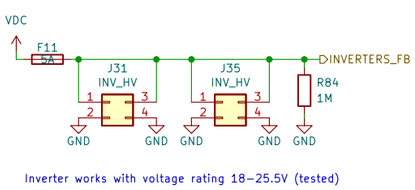


SHUTDOWN POWER SUPPLY

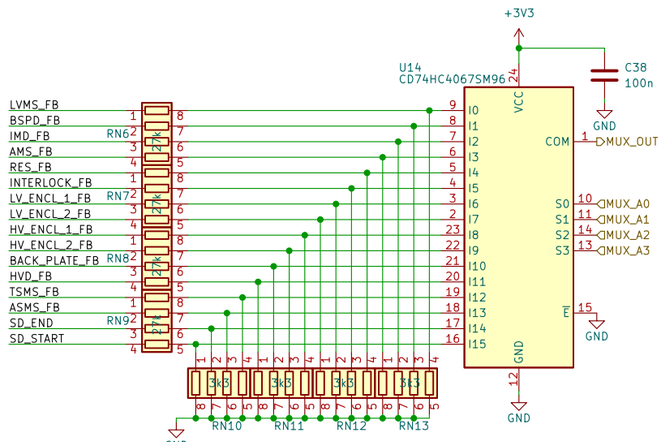


INVERTERS

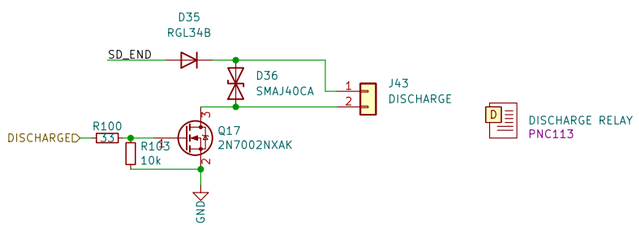


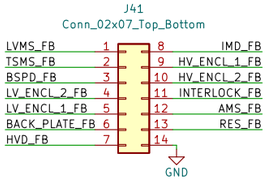


SHUTDOWN FEEDBACKS



DISCHARGE MOSFET





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Nicolò Durisotto

E-Agle TRT

Sheet: /LVS/
File: LVS.kicad_sch

Title: Fenice BMS LV

Size: A3	Date: 2021-10-12	**Rev: 1.1**
KiCad E.D.A. eeschema (6.0.2-0)		Id: 7/5