NOTES

(1) – When the charger GLV system is connected to the accumulator, power will be applied to the input of the GLVMS and power will drive the AIRs through the full shutdown loop

Wire Color Coding

- 35 mm^2 – Orange4
- 2AWG – Orange3
- 8AWG – Blue4
- 12AWG – Magenta2
- 18AWG – Yellow3
- 20AWG – Cyan3
- 22AWG – Green Default(#009600FF)
- 26AWG – Orange1
- 30AWG – Magenta3

Dashboard

Dashboard

RV101 R_POT
RV102 R_POT
RV103 R_POT
RV104 R_POT
Throttle Input
Brake Pressure Sensors

POT1+
POT1_INPUT
POT1–
POT2+
POT2_INPUT
POT2–
BRAKE1+
BRAKE1_INPUT
BRAKE1–
BRAKE2+
BRAKE2_INPUT
BRAKE2–
GLV+
CAN_Fault
GND

Speaker1+
Speaker1–
LS101 Speaker
Ready-to-Drive Sound
Speaker2+
Speaker2–
LS102 Speaker

Wheel_GLV
Wheel_GND
Wheel_CAN_H
Wheel_CAN_L
Wheel_CAN_S

CAN_H
CAN_L
CAN_Shield
StartEnable

22AWG

CHASSIS

File: Dashboard.kicad_sch

IMD Fault Indicator D102
BMS Fault Indicator D103
CAN Fault Indicator D104
Fault Indicators located on the Dashboard

Wheel

Wheel

GLV
GND
RadioPTT1
RadioPTT2
ToRadio
ToRadio
CAN_H
CAN_L
CAN_Shield

File: Wheel.kicad_sch

CANBUS

CANBUS

3x 20AWG
3x 20AWG

Power Distribution

Power Distribution

12V_Dashboard
CAN_Fault
IMD_Fault_Indicator
BMS_Fault_Indicator
CAN_Fault_Indicator
CAN_H
CAN_L
CAN_SHDN
CAN_LED

12V_MotorController
SD_FromBrakeOT
SD_ToBrakeOT
SD_FromBRBs
SD_ToBRBs
12V_Breaker
GND

SW101 Brake Over-Travel Switch
SW102 Side BRB
SW103 Side BRB
SW104 GLVMS
CB101 GLV Main Breaker 30A
BT101 GLV Battery 12V
Removable LFP Battery
8AWG
12AWG
8AWG
CHASSIS

File: PDU.kicad_sch

SHUTDOWN LOOP

SHUTDOWN LOOP

SW105 Cockpit BRB
SW106 TSMS
SHUTDOWN LOOP

SD_ToCockpit
SD_FromTSMS
IMD_Fault
BMS_Fault
12V_Battbox
IMD_Latch_Reset
BMS_Latch_Reset

22AWG
22AWG
22AWG

Enclosed PCB containing relays and fuses for 12V power distribution. Also latching relays to open shutdown loop and latch in the event of faults

12V_BattboxFansR1
12V_BattboxFansR2
12V_BattboxFansL1
12V_BattboxFansL2
12V_Pump
12V_RadiatorFan

12V_Brakelight
BRAKE LIGHT D101
Brake Light

18AWG
18AWG

M101 RadFan
M102 RadFan
M103 Cooling Pump
CHASSIS
CHASSIS
Powertrain Cooling

All grounds marked with this symbol are directly grounded to the vehicle frame

Accumulator Container

Accumulator Container

ShutdownLoop_GLV+
IMD_Fault
BMS_Fault
LVPlate_GLV+
TSMP–
TSMP+
TSAL_150V
TSAL_ACTIVE
GND
IMD_GND1
IMD_GND2

18AWG

File: Accumulator_Container.kicad_sch

J101
TS–
TS+
J102
GND
J103
TPST MOMENTARY BUTTON SW107
TSMP and Shutdown Reset Container

D105 TSAL_150V_LED
TSAL_ACTIVE_LED D106
22AWG
CHASSIS
CHASSIS_POINT0101
CHASSIS_POINT0102

GLV_CANH
GLV_CANL
GLV_CANS
MC_AIR+
MC_Precharge+

22AWG
22AWG

M104 RadFan
M105 RadFan
M106 RadFan
M107 RadFan
M108 RadFan
M109 RadFan
M110 RadFan
M111 RadFan
CHASSIS
CHASSIS
CHASSIS
CHASSIS
Accumulator Fans

Charger

Connected only while charging

Charge_Safety
CHRG_GND
CHRG_CANH
CHRG_CANL
CHRG_CANS
CHRG_DETECT1
CHRG_DETECT2

22AWG
18AWG
3x 20AWG

Charger
Charger_Safety
GND
CAN_H
CAN_L
CAN_Shield
TS+
TS–
35mm^2

File: Charger.kicad_sch

TS+
TS–
35mm^2
MAIN TS

Motor Controller Shelf

Motor Controller Shelf

22AWG
22AWG
22AWG

RXD
TXD
CANB_L
CANB_H
CANA_L
CANA_H
GND
DIN7_User_Defined
DIN6_Start
DIN5_Ignition
DIN4_REGEN_Disable
DIN3_Brake
DIN2_Reverse
DIN1_Forward
AIN6
AOUT
XDCR_PWR
AGND
AIN4
AIN3_Brake
XDCR_PWR
AGND_Accel
AIN2_Motor_Temp
AIN1_Accel
XDCR_PWR_Accel
J1

BATT+
BATT+
RLY4_Fault
RLY3_OK
RLY2_Main
RLY1_PreCharge
GND
GND
GND_Resolver
/COS
COS
/SIN
SIN
GND_Resolver
EXC_Resolver
GND_Encoder
ENCZ
ENCB
ENCA
XDCR_PWR_Encoder
J2

CHASSIS
22AWG
8x 22AWG

Phase_C
Phase_B
Phase_A
TS+
TS–
35mm^2
22AWG

R101 3.01K
RinehartPM100DX_MotorController U101
Resolver_IF
Phase_C
Phase_B
Phase_A
Emrax 228MV Motor U102

Motor controller disconnected from TS while charging

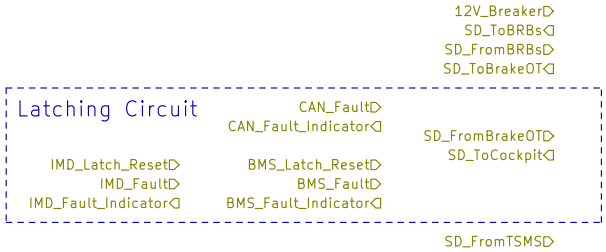
For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /
File: Master System Schematic.kicad_sch

Title: NER 2021–2022 Master Electrical Schematic

Size: A2	Date: 2023-01-25	**Rev: 18**
KiCad E.D.A. kicad (6.0.10-0)		Id: 1/13

SEE ALTIUM SCHEMATIC FOR FINAL IMPLEMENTATION



12V_Brakelight
12V_RadiatorFan
12V_Battbox
12V_Dashboard
12V_Pump
12V_MotorController
12V_BattboxFansL1
12V_BattboxFansL2
12V_BattboxFansR1
12V_BattboxFansR2

GND

CAN_L
CAN_H
CAN_S

For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Power Distribution/
File: PDU.kicad_sch

Title: Power Distribution Board

Size: A	Date: 2023-01-23	**Rev: 1**
KiCad E.D.A. kicad (6.0.10-0)		Id: 2/13

Main Processing Unit (MPU)

A301
NERduino

Speaker1+
Speaker2+
StartEnable
CAN_Fault
DIGITAL_BUF1
DIGITAL_BUF2
DIGITAL_BUF3
DIGITAL_BUF4
DIGITAL_BUF5
DIGITAL_BUF6
DIGITAL_T7
DIGITAL_T8
DIGITAL_T9
DIGITAL_T10
DIGITAL_T11
DIGITAL_T12
DIGITAL_T13
DIGITAL_T14
POT1_INPUT
POT2_INPUT
BRAKE1_INPUT
BRAKE2_INPUT
ANALOG_BUF1
ANALOG_BUF2
ANALOG_BUF3
ANALOG_BUF4
ANALOG_BUF5
ANALOG_BUF6
ANALOG_BUF7
ANALOG_BUF8
DRIVE_HIGH
DRIVE_LOW
PWM_OUT
12V
5V
3.3V
GND
I2C1.SCL
I2C1.SDA
I2C2.SCL
I2C2.SDA
SPI1.SCK
SPI1.CS
SPI1.MOSI
SPI1.MISO
SPI2.SCK
SPI2.CS
SPI2.MOSI
SPI2.MISO
CAN1.H
CAN1.L
CAN2.H
CAN2.L
RELAY_NO
RELAY_IN
RELAY_NC

POT1+
POT1−
POT2+
POT2−
BRAKE1+
BRAKE1−
BRAKE2+
BRAKE2−
GND
GLV+

U301
CAN_Bus_Module
5_VDC
Ground
Chip_Select
MISO
MOSI
Serial_Clock
Interrupt
CAN_Low
CAN_High

CAN_H
CAN_L
Wheel_CAN_H
Wheel_CAN_L

A302
NERduino

GND
Wheel_GND
Wheel_CAN_S
Wheel_GLV
Speaker1−
Speaker2−
CAN_Shield
GND

U302
CAN_Bus_Module
5_VDC
Ground
Chip_Select
MISO
MOSI
Serial_Clock
Interrupt
CAN_Low
CAN_High

Telemetry Control Unit (TCU)

PS301
ITX0512SA
+Vin
−Vin
+Vout
−Vout
GND
GND

J301
Raspberry_Pi_2_3
3V3
5V
ID_SD/GPIO0
ID_SC/GPIO1
SDA/GPIO2
SCL/GPIO3
GCLK0/GPIO4
GCLK1/GPIO5
GCLK2/GPIO6
CE1/GPIO7
CE0/GPIO8
MISO0/GPIO9
MOSI0/GPIO10
SCLK0/GPIO11
PWM0/GPIO12
PWM1/GPIO13
GPIO14/TXD
GPIO15/RXD
GPIO16
GPIO17
GPIO18/PWM0
GPIO19/MISO1
GPIO20/MOSI1
GPIO21/SCLK1
GPIO22
GPIO23
GPIO24
GPIO25
GPIO26
GPIO27
GND

U303
CAN_Bus_Module
Interrupt
Serial_Clock
MOSI
MISO
Chip_Select
Ground
5_VDC
CAN_High
CAN_Low

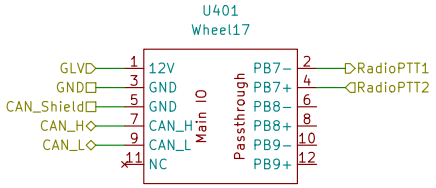
Dashboard Display Driver

For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Dashboard/
File: Dashboard.kicad_sch

Title: Footwell Box

Size: B	Date: 2022-03-30	**Rev: 1**
KiCad E.D.A. kicad (6.0.10-0)		Id: 3/13

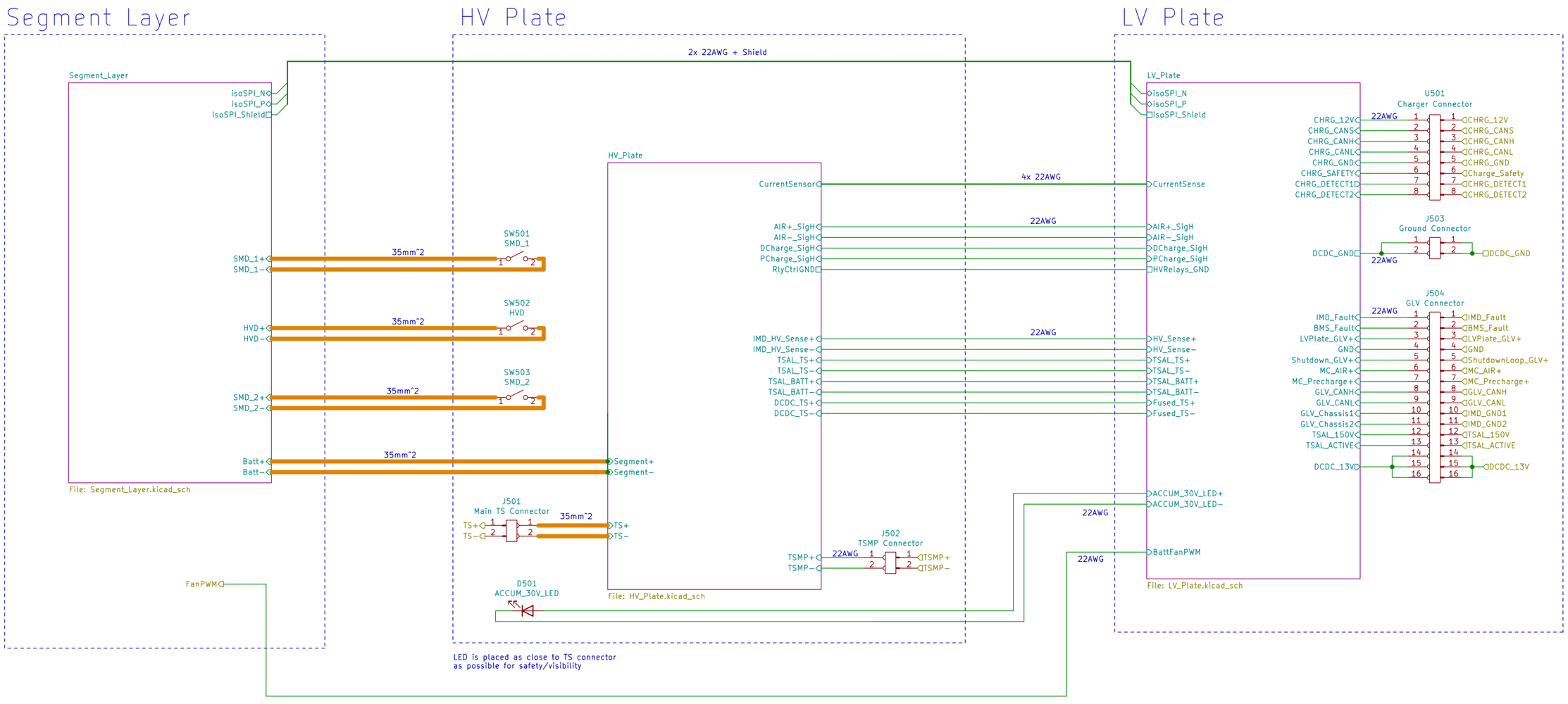


For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Wheel/
File: Wheel.kicad_sch

Title: Wheel PCB

Size: A	Date: 2023-01-25	**Rev: 1**
KiCad E.D.A. kicad (6.0.10-0)		Id: 4/13



For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER

Northeastern Electric Racing

Sheet: /Accumulator Container/
File: Accumulator_Container.kicad_sch

Title: Accumulator Container

Size: B	Date: 2023-01-25	**Rev: 8**
KiCad E.D.A. kicad (6.0.10-0)		Id: 5/13

ALL WIRES 22AWG EXCEPT WHERE LABELED

To HV Plate area
ACCUM_30V_LED-
ACCUM_30V_LED+

U604
TSAL17
LV Side
LED_GND
30V_LED
LED_GND
ACTIVE_LED
LED_GND
150V_LED
HV Side
BATT-
BATT+
TS-
TS+

From HV Plate below
TSAL_TS-
TSAL_TS+
TSAL_BATT-
TSAL_BATT+

U601
Bender_Isometer_IR155-3204
STATUS_OK
+12V_Supply
GND
HV_Sense+
HV_Sense-
CHASSIS_GND2
CHASSIS_GND1

GLV_Chassis1
GLV_Chassis2
IMD_Fault

Fused_TS-
Fused_TS+

U603
TS-GLV17
HV Side
TS-
TS+
LV Side
PGOOD
VoltMeas
CurrMeas
GND
13V
GND

To HV Plate control connector
AIR+_SigH
AIR-_SigH
DCharge_SigH
PCharge_SigH
HVRelays_GND
MC_AIR+
Shutdown_GLV+
MC_Precharge+

GLV Connector
TSAL_ACTIVE
TSAL_150V
GND
LVPlate_GLV+
GLV_CANH
GLV_CANL
BMS_Fault
DCDC_GND
DCDC_13V

3x 22AWG

U602
Shep_Controller
Main IO
1 GND
2 GND
3 CAN1_L
4 CAN1_H
5 GND
6 GND
7 CAN2_L
8 CAN2_H
9 GND
10 GND
11 Fault_Rly
12 Fault_Rly
13 Analog5
14 Analog6
15 Analog3
16 Analog4
17 GND
18 GND
19 Digital5
20 Digital6
21 Digital3
22 Digital4
23,24 GND
25,26 3.3V
27,28 GND
29,30 5V
31,32 GND

Accumulator IO
1 12V
2 GND
3 FAN_PWM
4 12V
5 GND
6 FAN_PWM
7 12V
8 GND
9 FAN_PWM
10 12V
11 GND
12 FAN_PWM
13 12V
14 GND
15 FAN_PWM
29 GND
30 5V
31 Analog1
32 Analog2

BattFan Hole/Cutout
BattFanPWM

4x 22AWG
CurrentSense

isoSPI
Shield
isoSPI_P
Shield
isoSPI_M
isoSPI_Shield
isoSPI_P
isoSPI_N

Charger Connector
CHRG_12VD
CHRG_CANH
CHRG_CANL
CHRG_CANS
CHRG_SAFETY
CHRG_DETECT2
CHRG_GND
CHRG_DETECT1
3x 22AWG

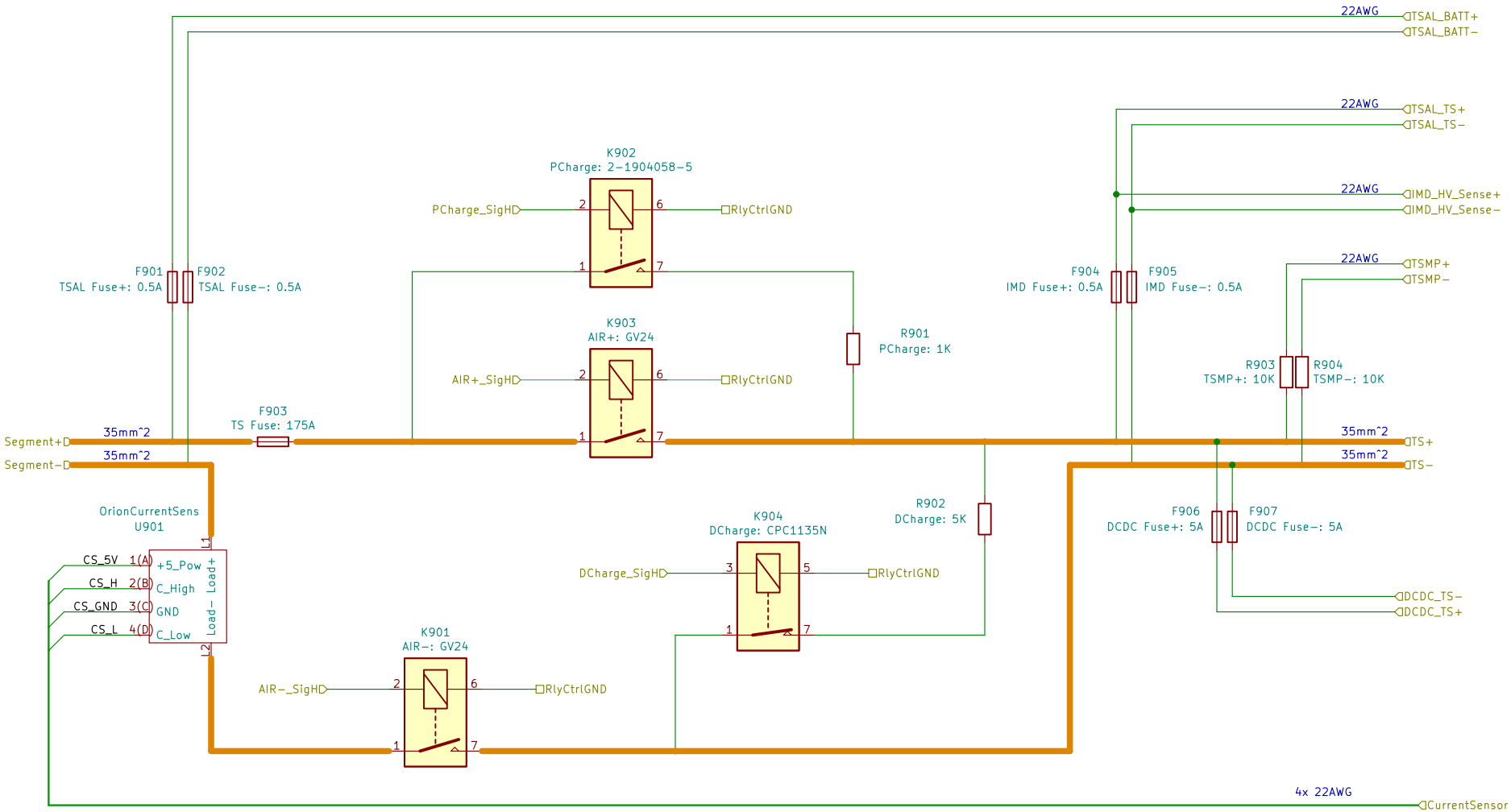
For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Accumulator Container/LV_Plate/
File: LV_Plate.kicad_sch

Title: LV Plate

Size: B	Date: 2023-01-25	**Rev: 2**
KiCad E.D.A. kicad (6.0.10-0)		Id: 6/13

SEE ALTIUM SCHEMATIC FOR FINAL IMPLEMENTATION

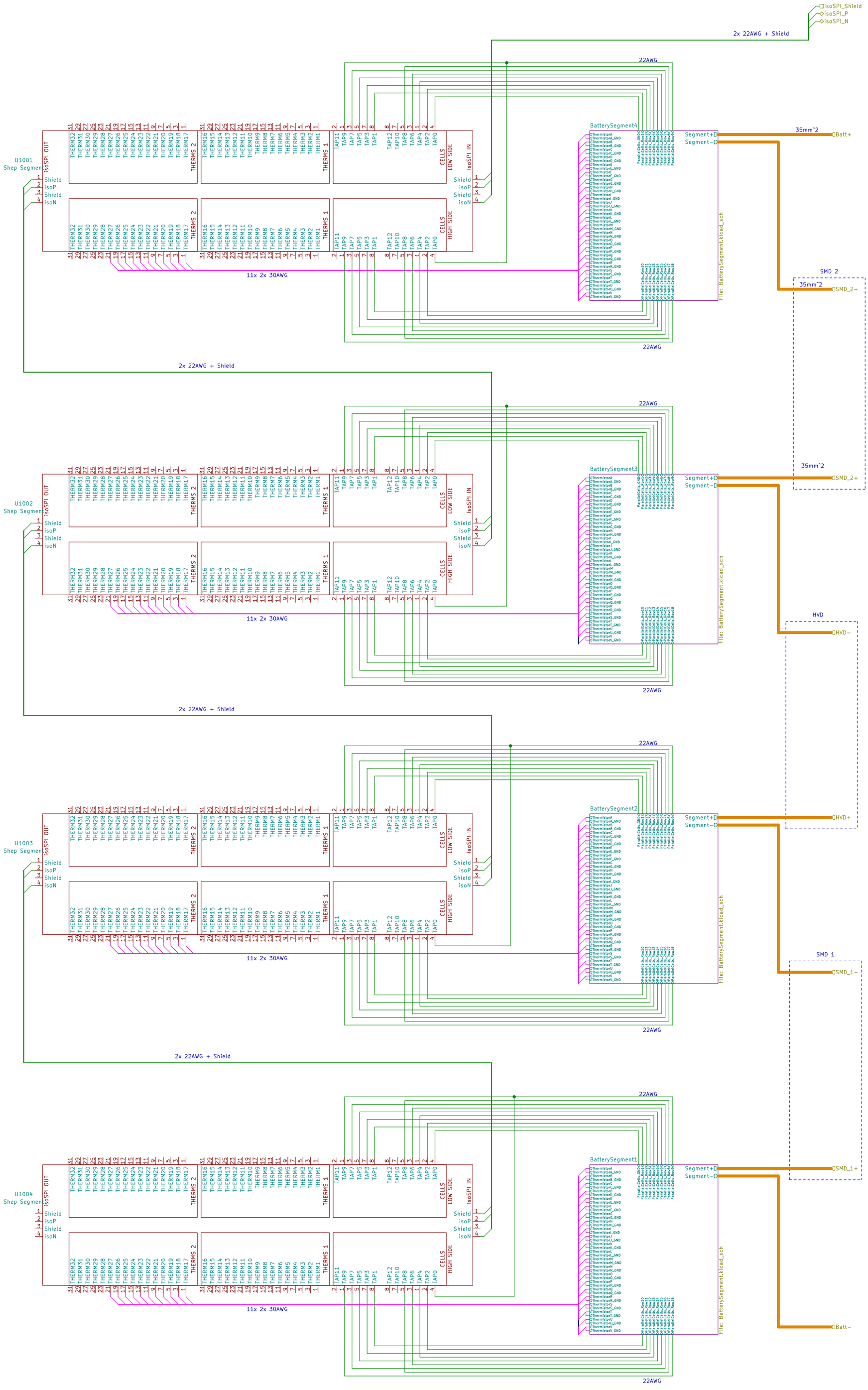


For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Accumulator Container/HV_Plate/
File: HV_Plate.kicad_sch

Title: HV Plate

Size: A	Date: 2023-01-24	**Rev: 2**
KiCad E.D.A. kicad (6.0.10-0)		Id: 9/13



For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER

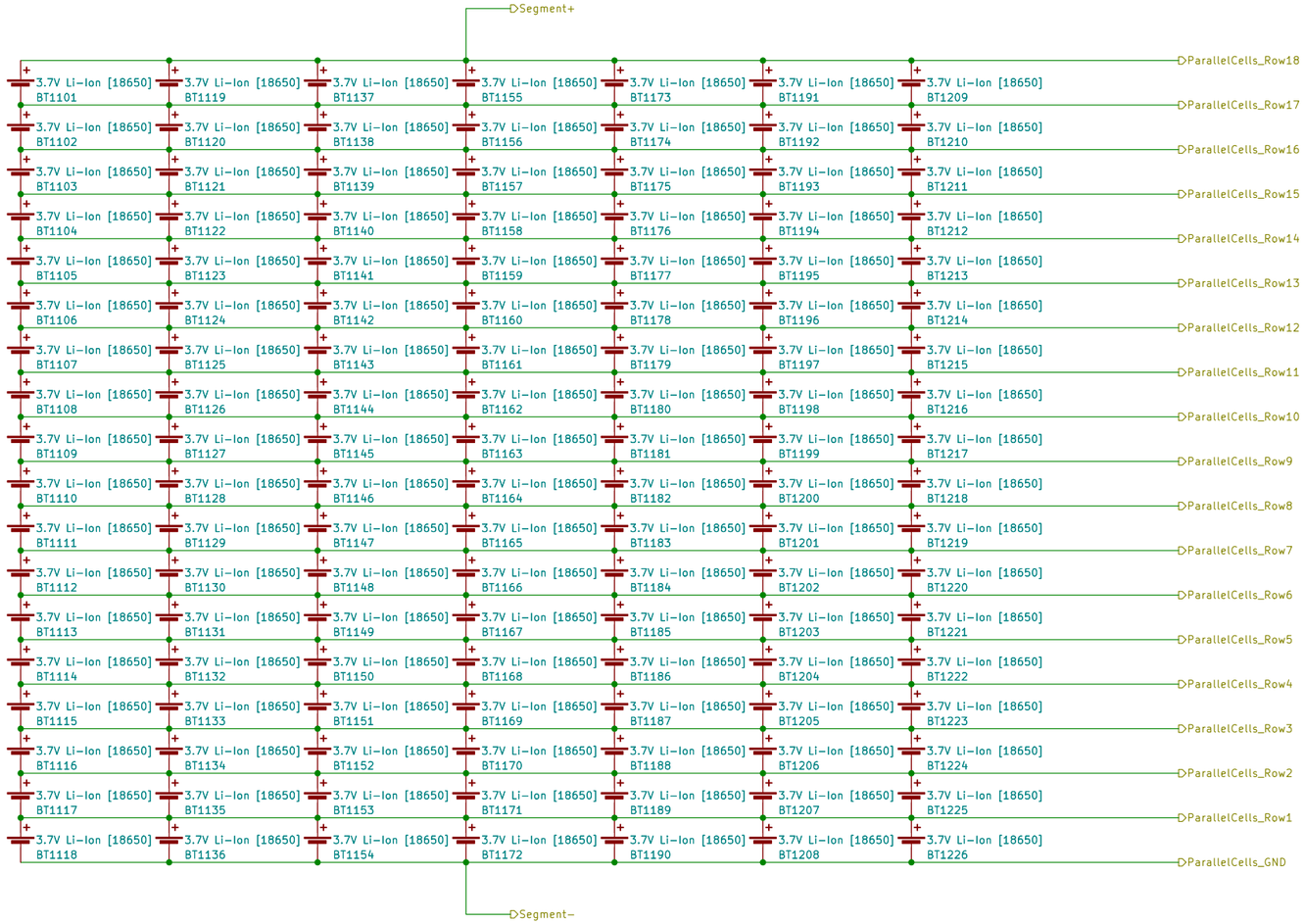
Northeastern Electric Racing

Sheet: /Accumulator Container/Segment_Layer/
File: Segment_Layer.kicad_sch

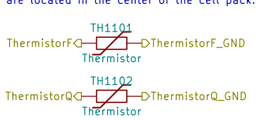
Title: Segment Layer

Size: C	Date: 2023-01-25	**Rev: 2**
KiCad E.D.A. kicad (6.0.10-0)		Id: 10/13

See Fusible Links Report 2022



Thermistors F & Q are critical, and are therefore independently grounded to the BMS. They are located in the center of the cell pack.



*Thermistors are distributed evenly throughout the segment. Each group of 5 has a common ground on the thermistor expansion.

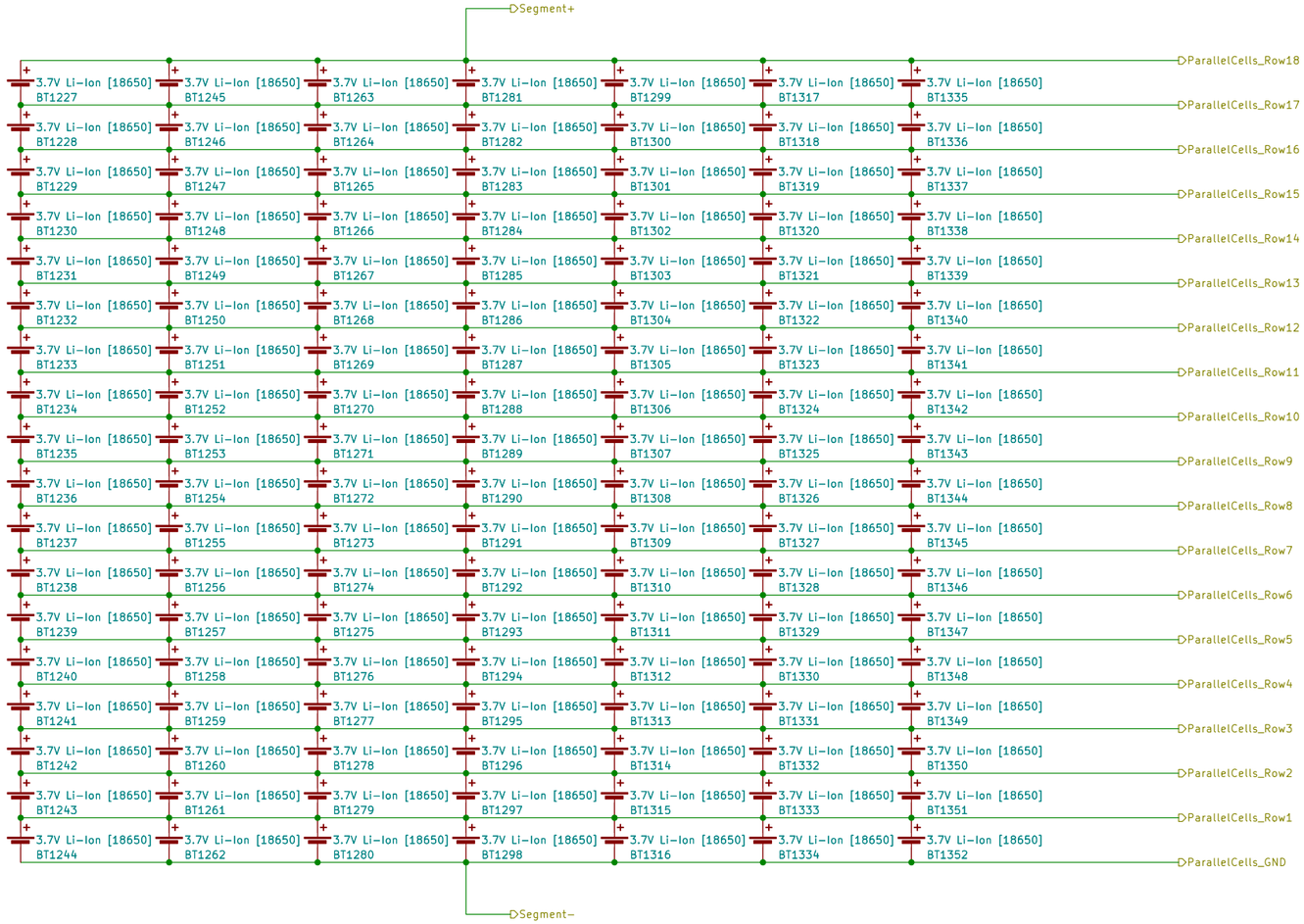
For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Accumulator Container/Segment_Layer/BatterySegment1/
File: BatterySegment.kicad_sch

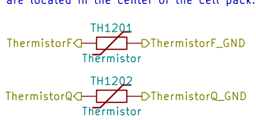
Title: Accumulator Segment

Size: B	Date: 2020-11-11	**Rev: 3**
KiCad E.D.A. kicad (6.0.10-0)		Id: 11/13

See Fusible Links Report 2022



Thermistors F & Q are critical, and are therefore independently grounded to the BMS. They are located in the center of the cell pack.



*Thermistors are distributed evenly throughout the segment. Each group of 5 has a common ground on the thermistor expansion.

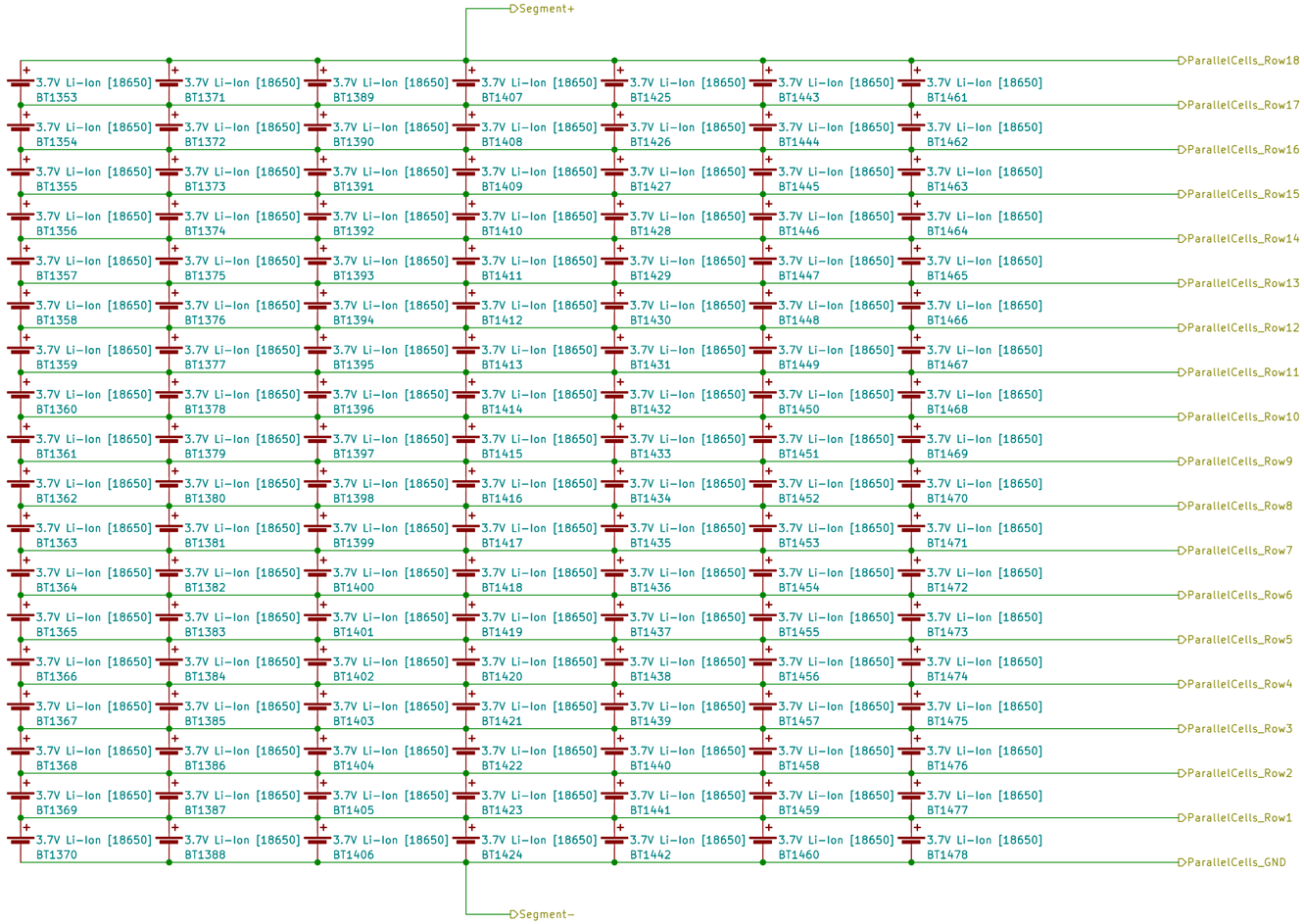
For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Accumulator Container/Segment_Layer/BatterySegment2/
File: BatterySegment.kicad_sch

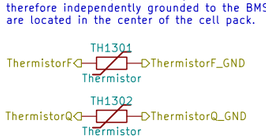
Title: Accumulator Segment

Size: B	Date: 2020-11-11	**Rev: 3**
KiCad E.D.A. kicad (6.0.10-0)		Id: 12/13

See Fusible Links Report 2022



Thermistors F & Q are critical, and are therefore independently grounded to the BMS. They are located in the center of the cell pack.



*Thermistors are distributed evenly throughout the segment. Each group of 5 has a common ground on the thermistor expansion.

For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER

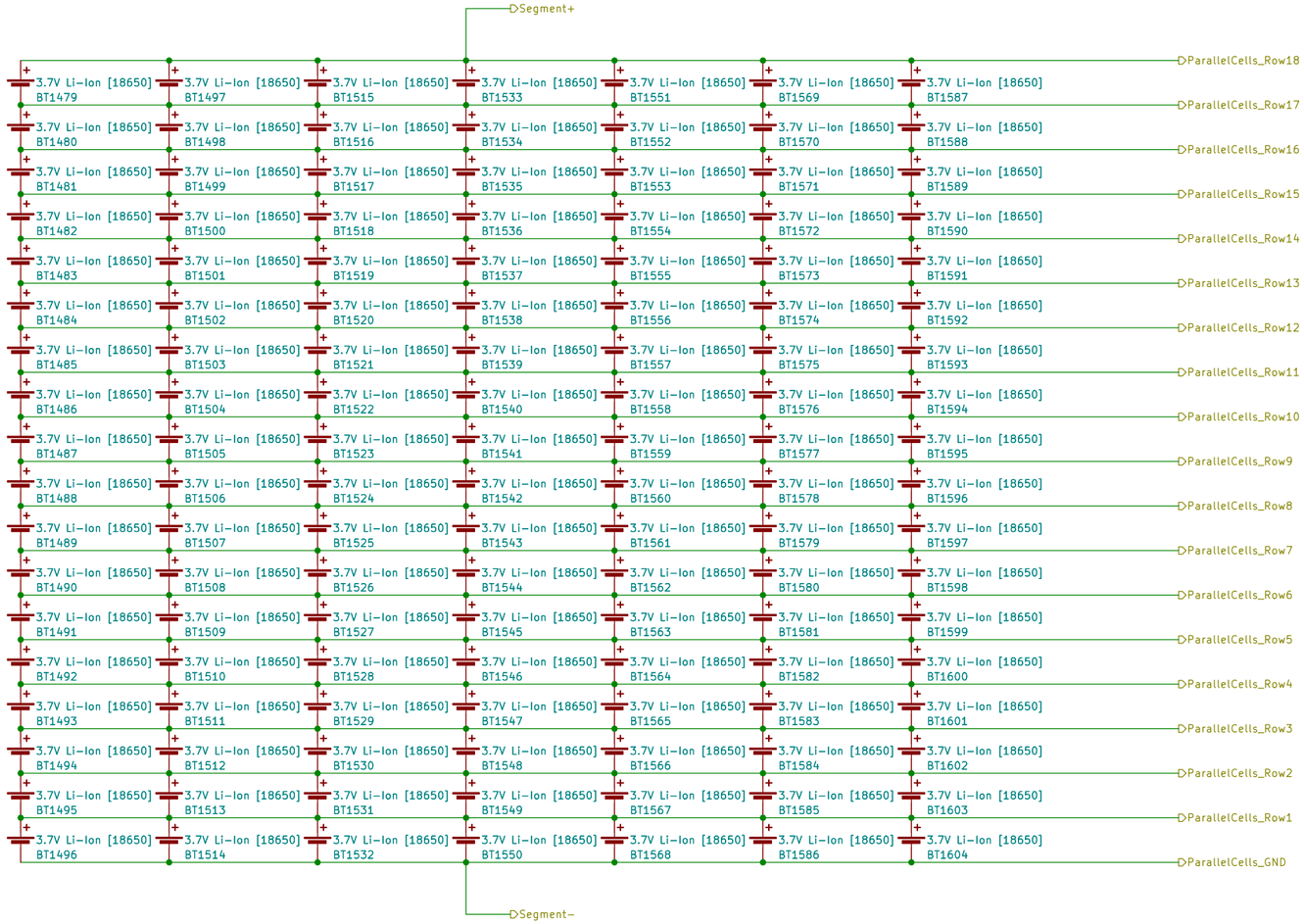
Northeastern Electric Racing

Sheet: /Accumulator Container/Segment_Layer/BatterySegment3/
File: BatterySegment.kicad_sch

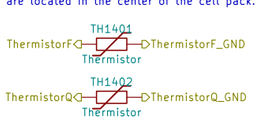
Title: Accumulator Segment

Size: B	Date: 2020-11-11	**Rev: 3**
KiCad E.D.A. kicad (6.0.10-0)		Id: 13/13

See Fusible Links Report 2022



Thermistors F & Q are critical, and are therefore independently grounded to the BMS. They are located in the center of the cell pack.



*Thermistors are distributed evenly throughout the segment. Each group of 5 has a common ground on the thermistor expansion.

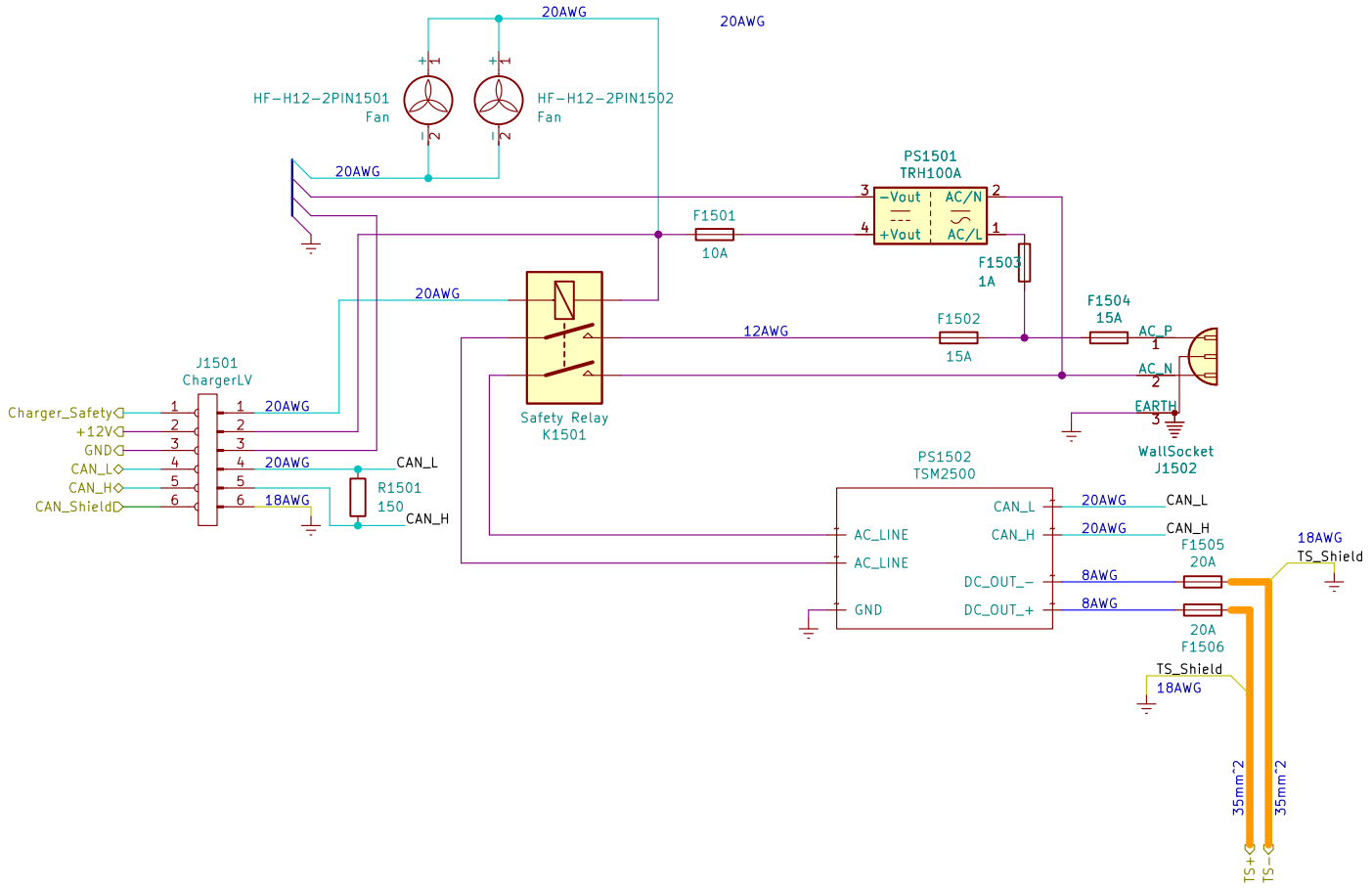
For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Accumulator Container/Segment_Layer/BatterySegment4/
File: BatterySegment.kicad_sch

Title: Accumulator Segment

Size: B	Date: 2020-11-11	**Rev: 3**
KiCad E.D.A. kicad (6.0.10-0)		Id: 14/13

All wires are 12 AWG unless specified



For authors and other info, contact Chief Electrical Engineer
https://github.com/Northeastern-Electric-Racing/NER
Northeastern Electric Racing

Sheet: /Charger/
File: Charger.kicad_sch

Title: Charging System

Size: A	Date: 2022-01-29	**Rev: 5**
KiCad E.D.A. kicad (6.0.10-0)		Id: 15/13