

RELEASED 2023-11-26

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DESIGN CONSIDERATIONS

DESIGN NOTE:
Example text for informational design notes.

DESIGN NOTE:
Example text for debug notes.

DESIGN NOTE:
Example text for cautionary design notes.

DESIGN NOTE:
Example text for critical design notes.

LAYOUT NOTE:
Example text for critical layout guidelines.

TOP VIEW



BOTTOM VIEW



NOTES

Not fitted components are marked as

DRAFT - Very early stage of schematic, ignore details.

PRELIMINARY - Close to final schematic.

CHECKED - There shouldn't be any mistakes.

RELEASED - A board has been sent to production.

Author: Vincent Nguyen

EPFL Xplore

Sheet: /

File: bldc_controller.kicad_sch

Title: Controller Top Level

Size: A3 Date: 2023-10-12

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 1/21

1 2 3 4 5 6

A

B

C

D

A

B

C

D

Sheet: /Block Diagram/
File: BlockDiagram.kicad_sch

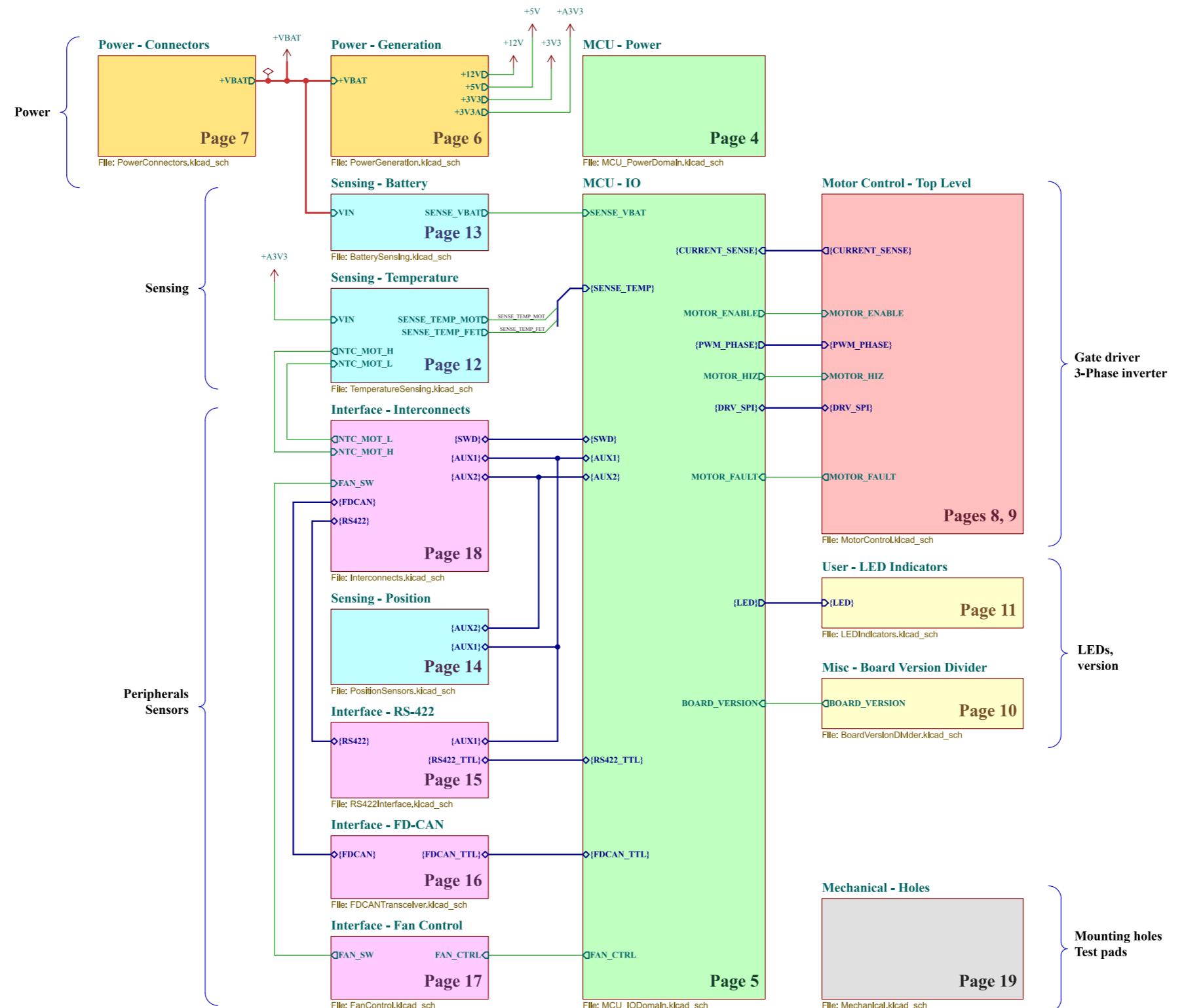
Title:

Size: A4 Date:
KiCad E.D.A. kicad 7.0.6

Rev:
Id: 2/21

1 2 3 4 5 6

[3] Project Architecture



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/
File: ProjectArchitecture.kicad_sch

Title: Project Architecture

| | |
|--------------------------|------------------|
| Size: A3 | Date: 2023-11-25 |
| KiCad E.D.A. kicad 7.0.6 | Rev: 1.0 |

| |
|----------|
| Id: 3/21 |
|----------|

[4] MCU - Power

A

B

C

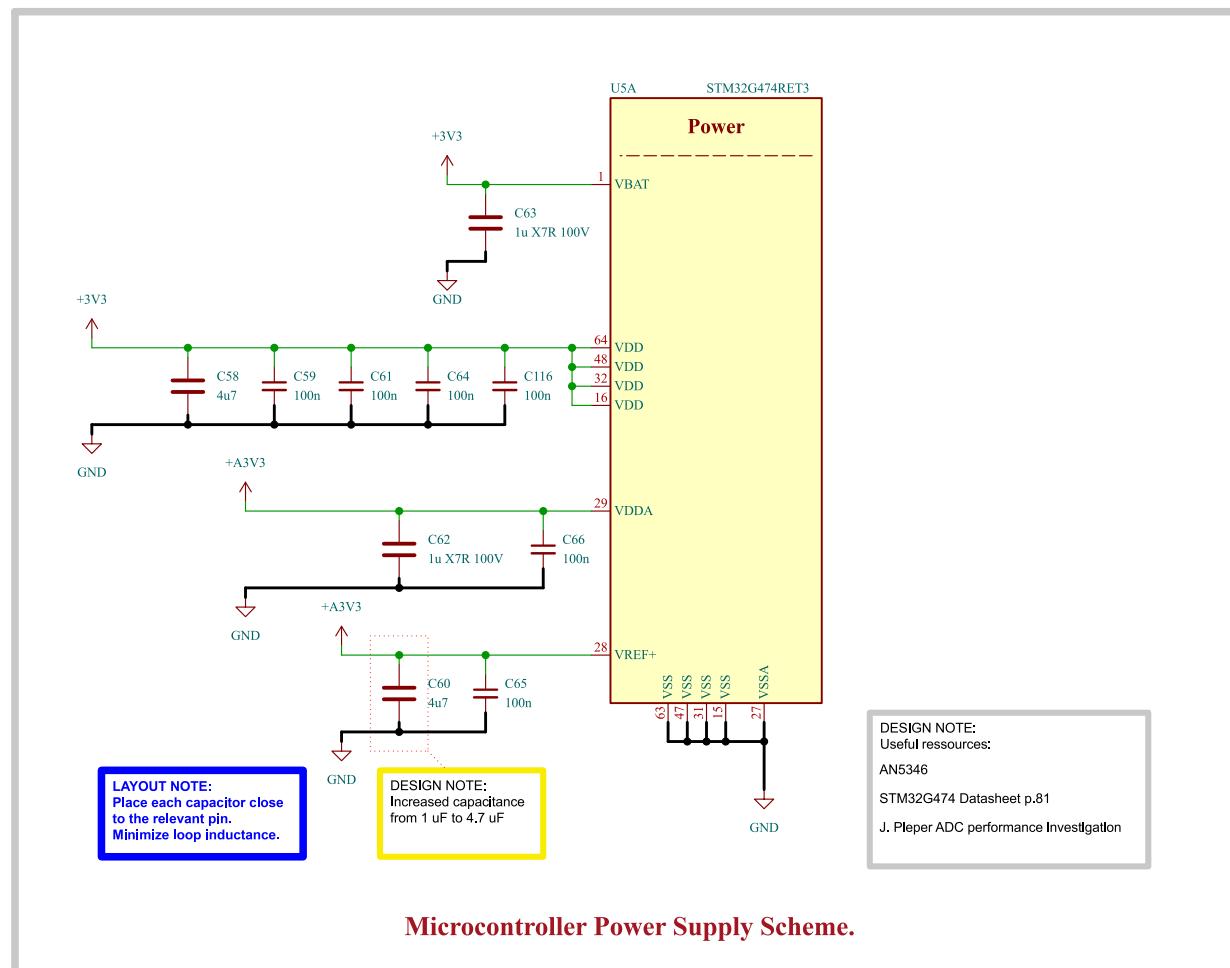
D

A

B

C

D



Author: Vincent Nguyen

EPFL Xplore

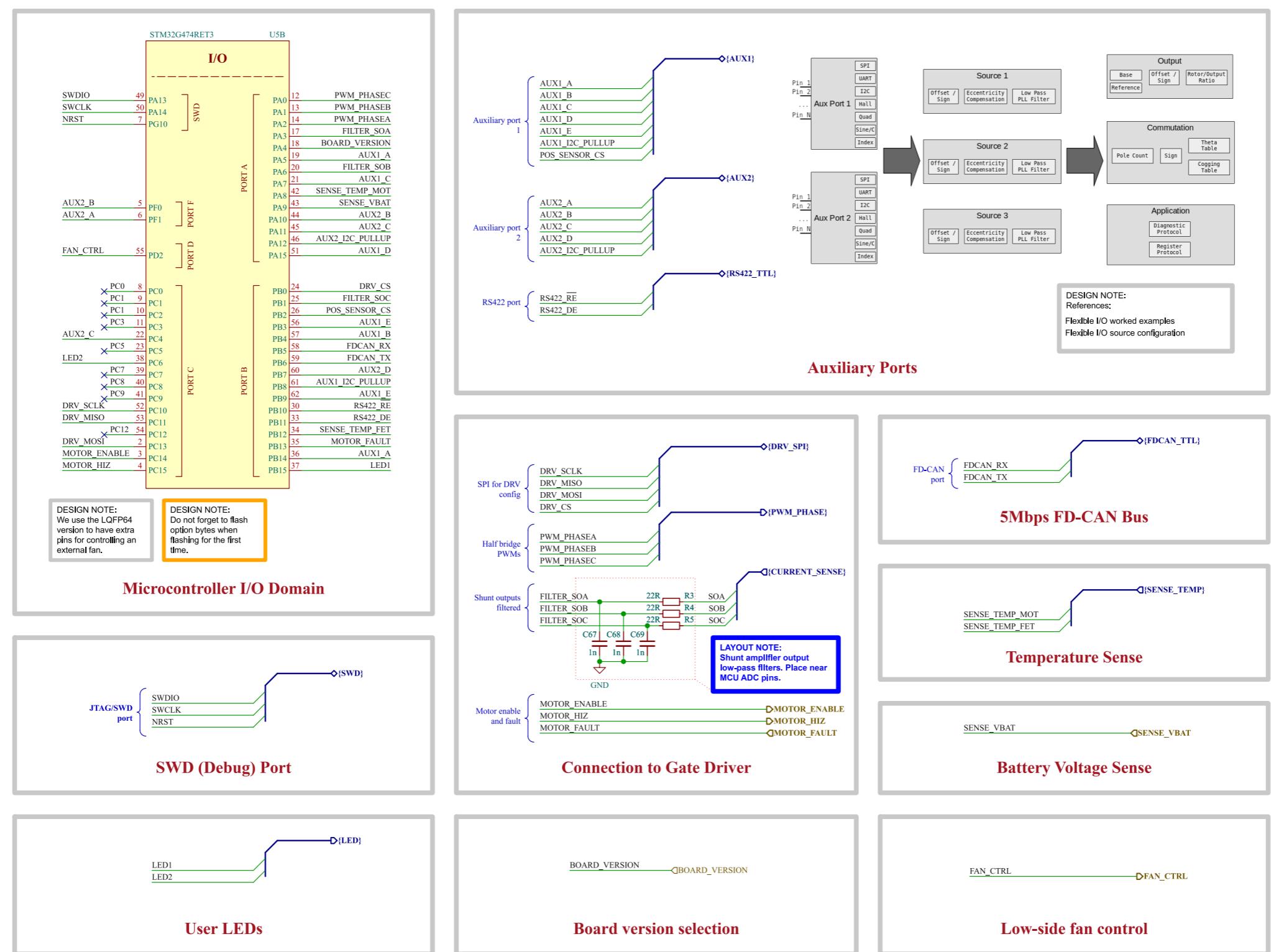
Sheet: /Project Architecture/MCU - Power/
File: MCU_PowerDomain.kicad_sch

Title: STM32G474 Power Domain

| | |
|--------------------------|------------------|
| Size: A4 | Date: 2023-10-14 |
| KiCad E.D.A. kicad 7.0.6 | |

| |
|----------|
| Rev: 1.0 |
| Id: 4/21 |

[5] MCU - IO



Author: Vincent Nguyen

EPFL Xplore

Sheet: Project Architecture/MCU - IO/

File: MCU_IODomain.kicad_sch

Title: STM32G474 I/O Domain

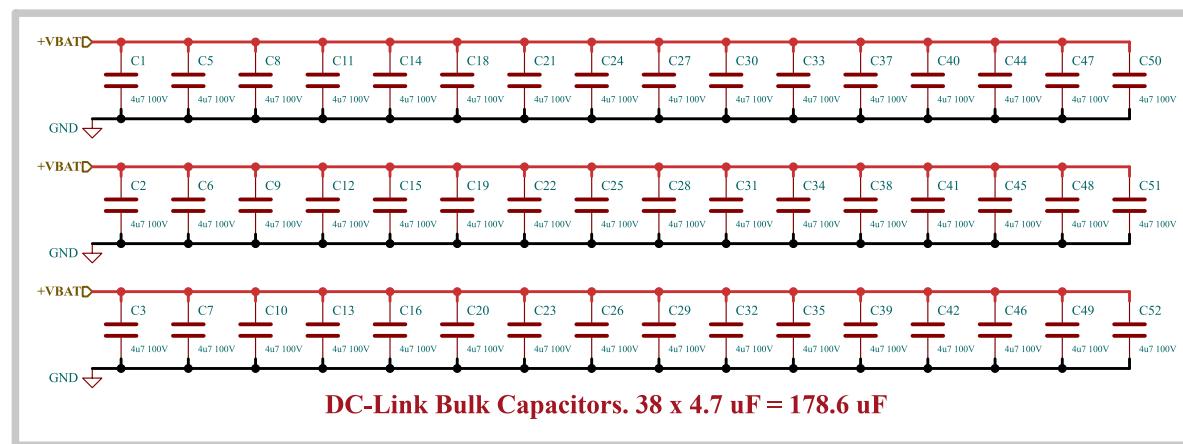
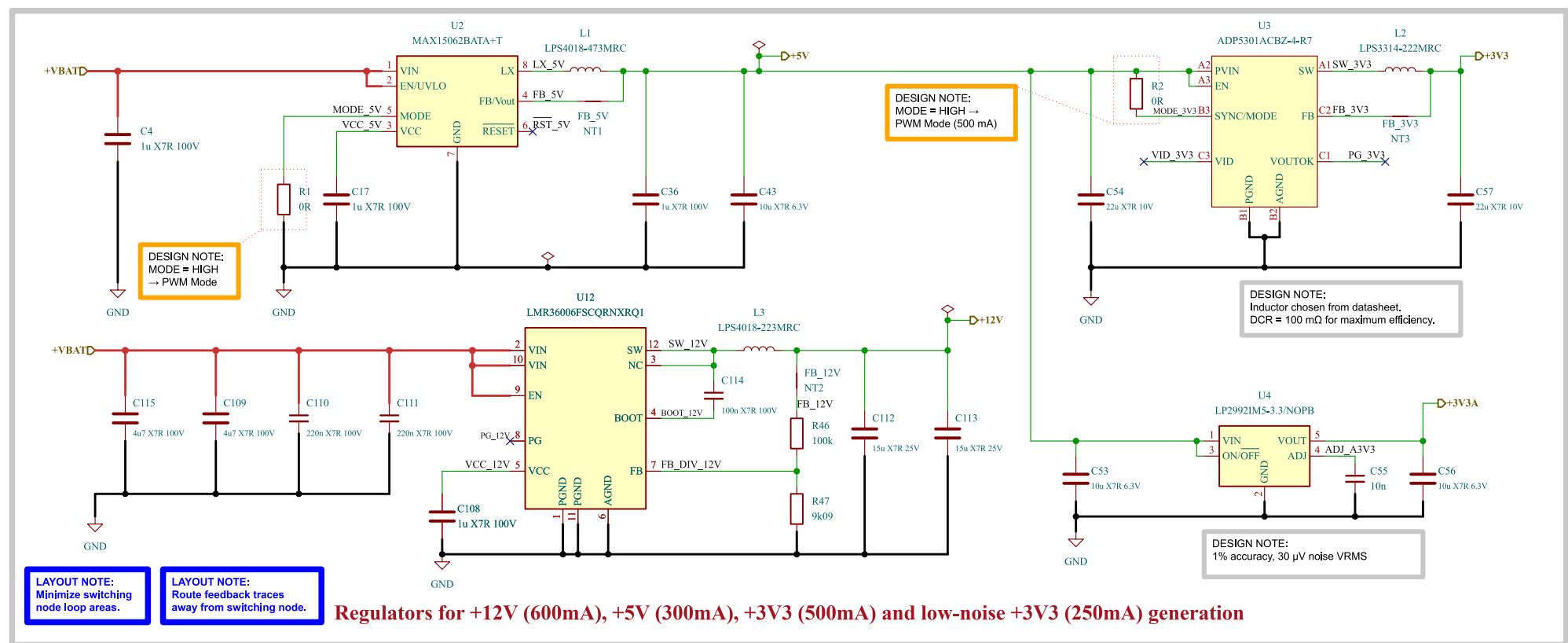
Size: A3 Date: 2023-10-14

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 5/21

[6] Power - Generation



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Power - Generation/
File: PowerGeneration.kicad_sch

Title: Power Generation

Size: A4 Date: 2023-10-21

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 6/21

[7] Power - Connectors

A

A

B

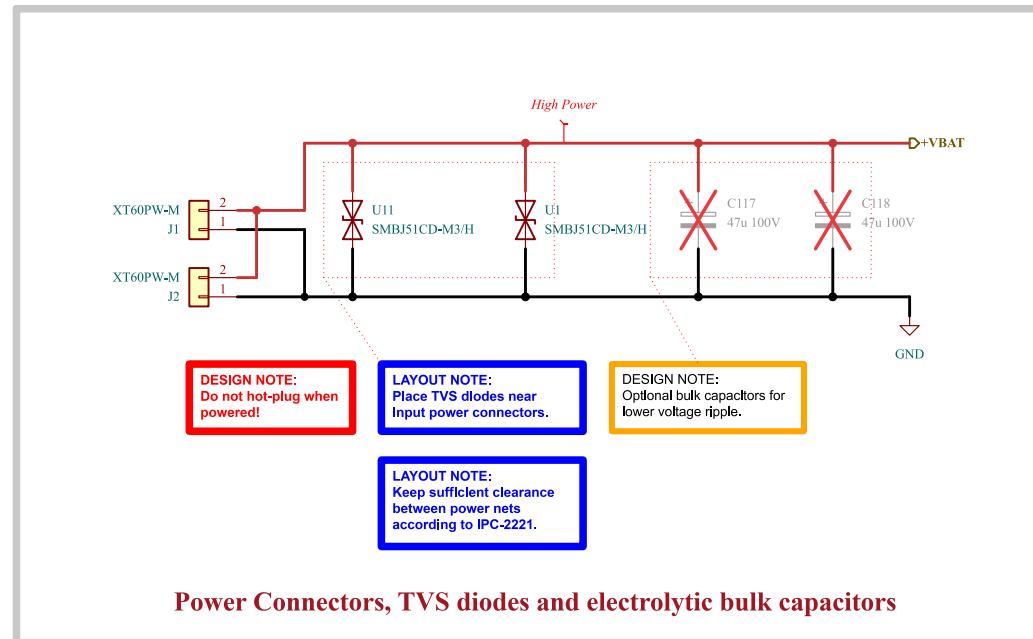
B

C

C

D

D



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Power - Connectors/
File: PowerConnectors.kicad_sch

Title: Power Connectors

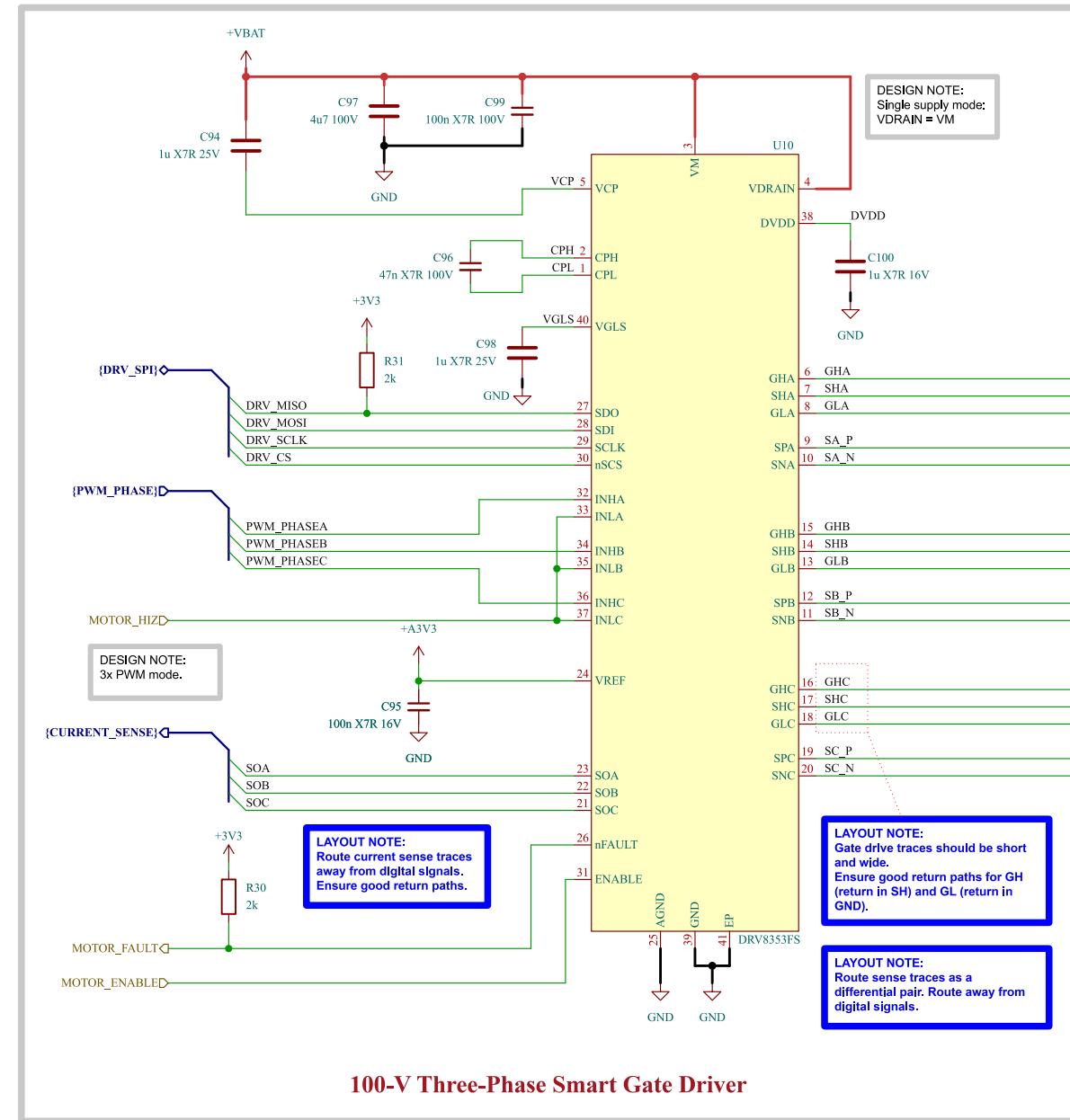
Size: A4 Date: 2023-10-14

KiCad E.D.A. kicad 7.0.6

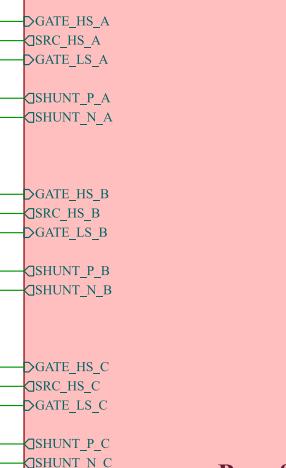
Rev: 1.0

Id: 7/21

[8] Motor Control - Top Level



Motor Control - Inverter



Page 9

File: MotorControl_ThreePhaseInverter.kicad_sch

Power Stage

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Motor Control - Top Level/
File: MotorControl.kicad_sch

Title: Motor Control Gate Driver

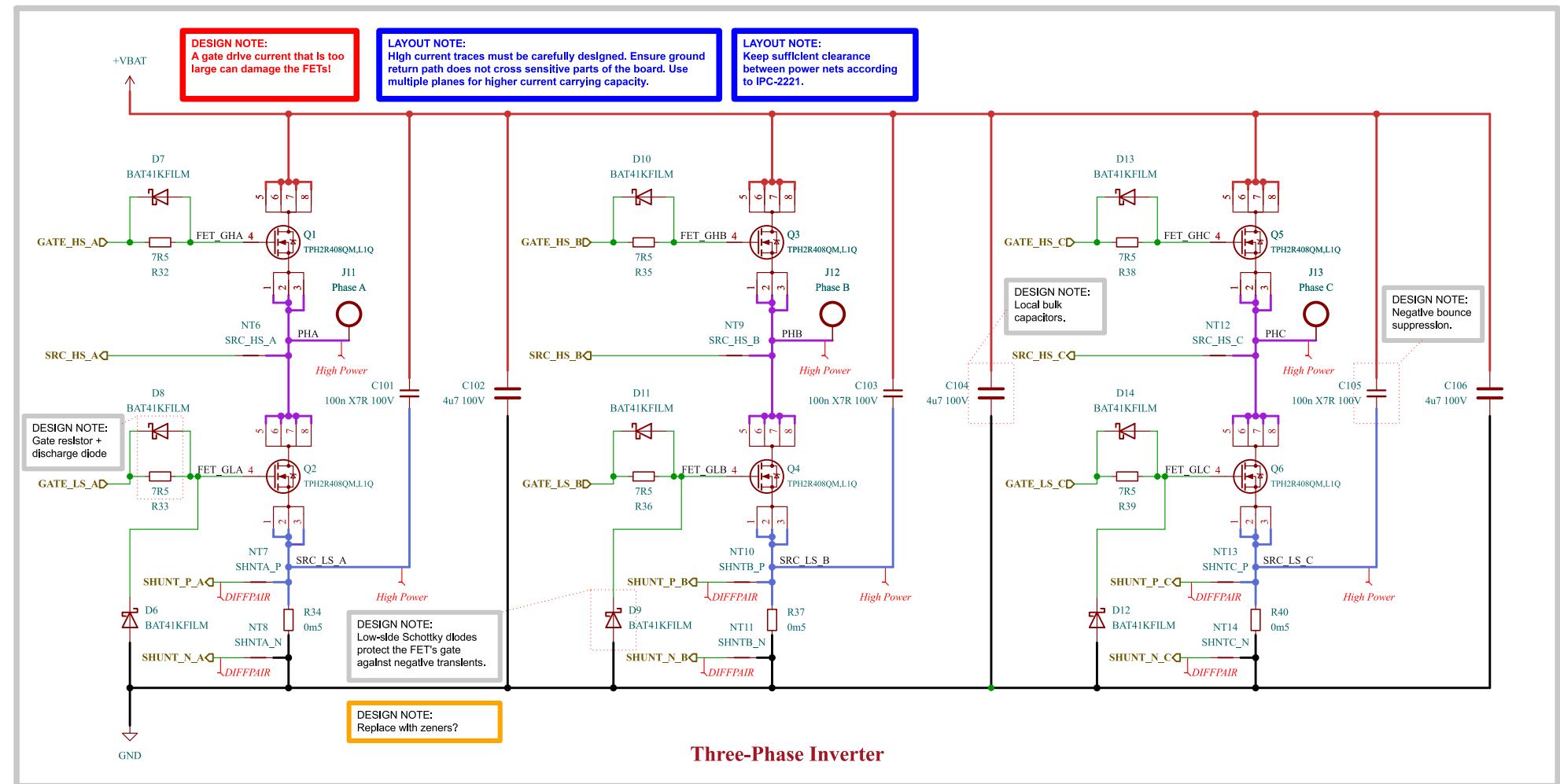
Size: A4 Date: 2023-10-16

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 8/21

[9] Motor Control - Inverter



DESIGN NOTE:
References:
 System Design Considerations for High-Power Motor Driver Applications
 Best Practices for Board Layout of Motor Drivers

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Motor Control - Top Level/Motor Control - Inverter/
 File: MotorControl_ThreePhaseInverter.kicad_sch

Title: Three Phase Driver

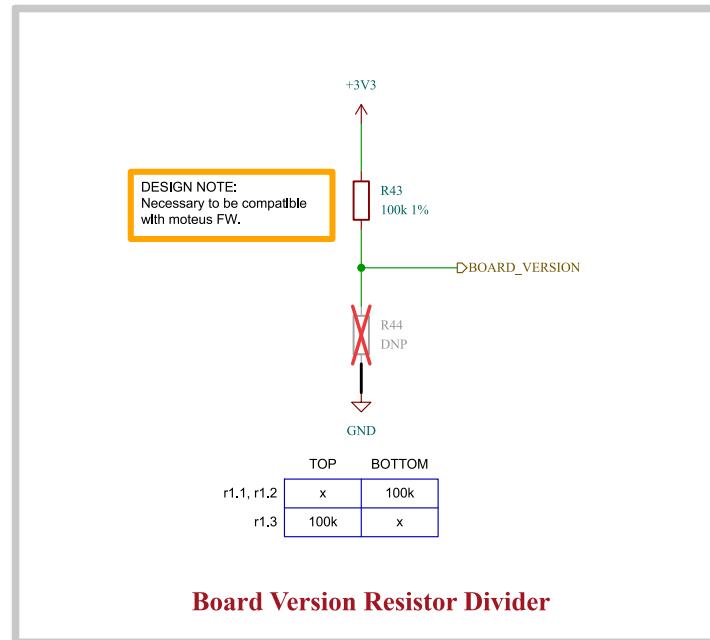
Size: A4 Date: 2023-10-18

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 9/21

[10] Misc - Board Version Divider



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Misc - Board Version Divider/
File: BoardVersionDivider.kicad_sch**Title: Board Version Resistor Divider**

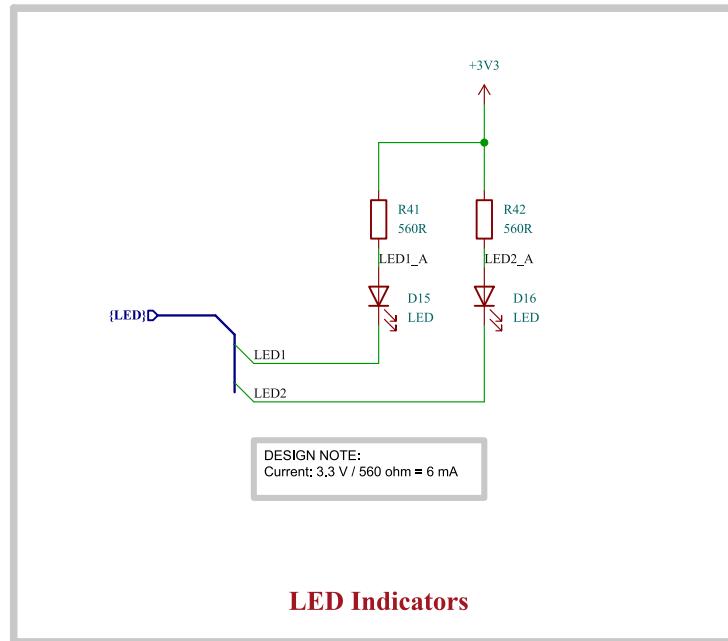
Size: A4 Date: 2023-10-14

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 10/21

[11] User - LED Indicators



LED Indicators

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/User - LED Indicators/
File: LEDIndicators.kicad_sch

Title: LED Indicators

Size: A4 Date: 2023-10-15
KiCad E.D.A. kicad 7.0.6

Rev: 1.0
Id: 11/21

[12] Sensing - Temperature

A

B

C

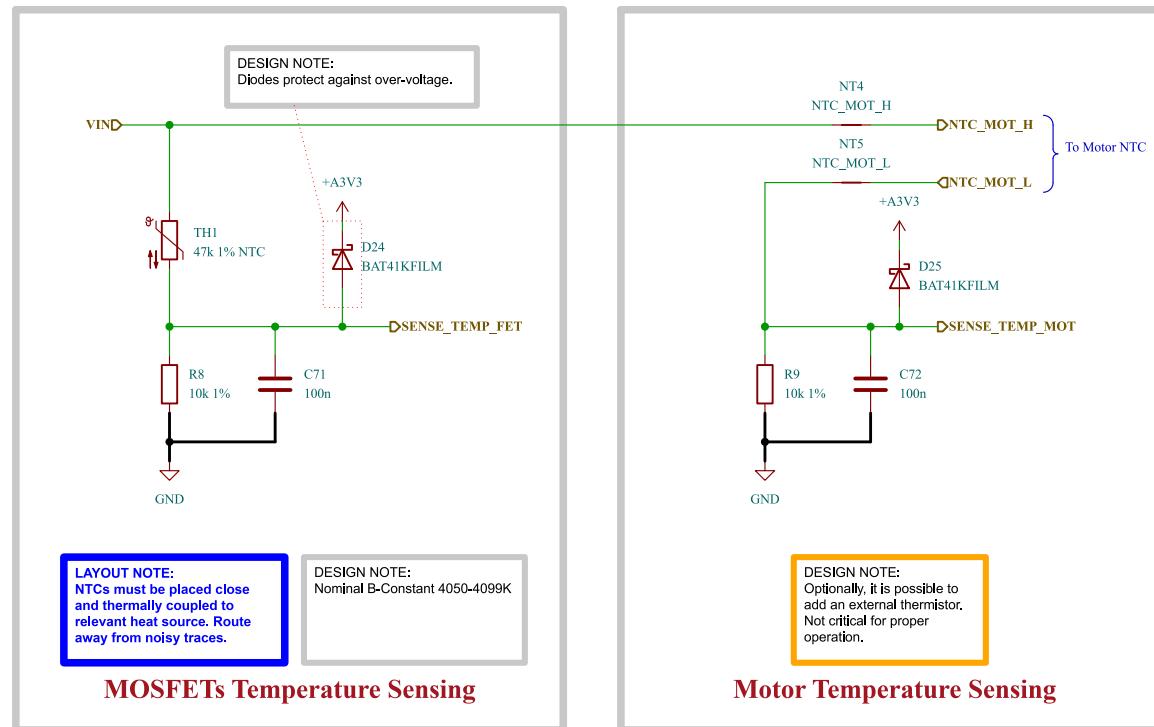
D

A

B

C

D



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Sensing - Temperature/
File: TemperatureSensing.kicad_sch

Title: Temperature Sensing

| | |
|--------------------------|------------------|
| Size: A4 | Date: 2023-10-14 |
| KiCad E.D.A. kicad 7.0.6 | |

| |
|-----------|
| Rev: 1.0 |
| Id: 12/21 |

[13] Sensing - Battery

A

B

C

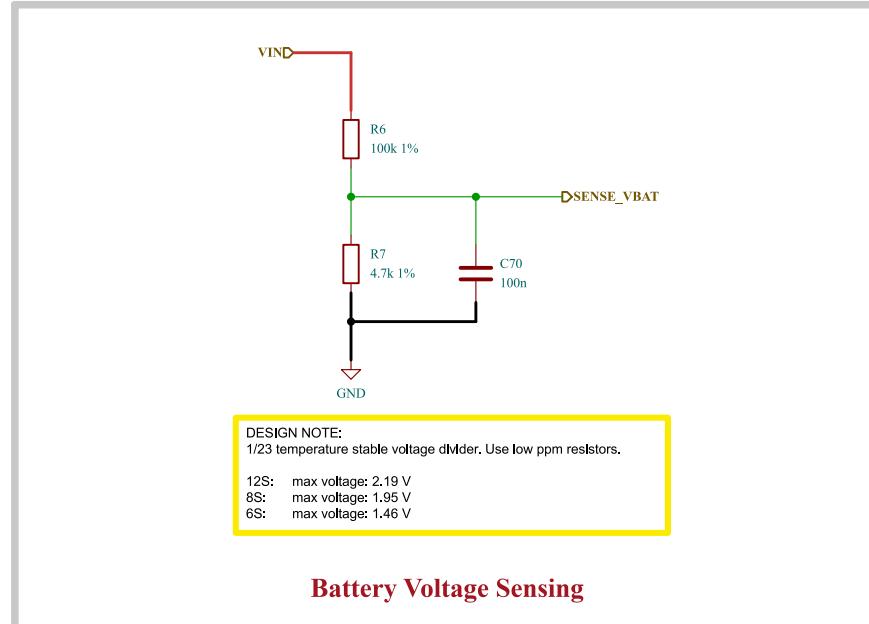
D

A

B

C

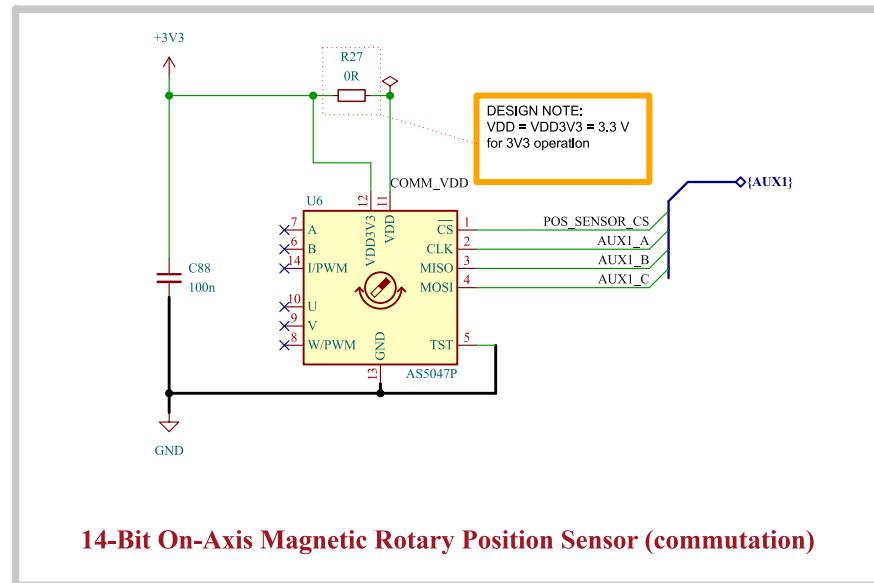
D



Author: Vincent Nguyen

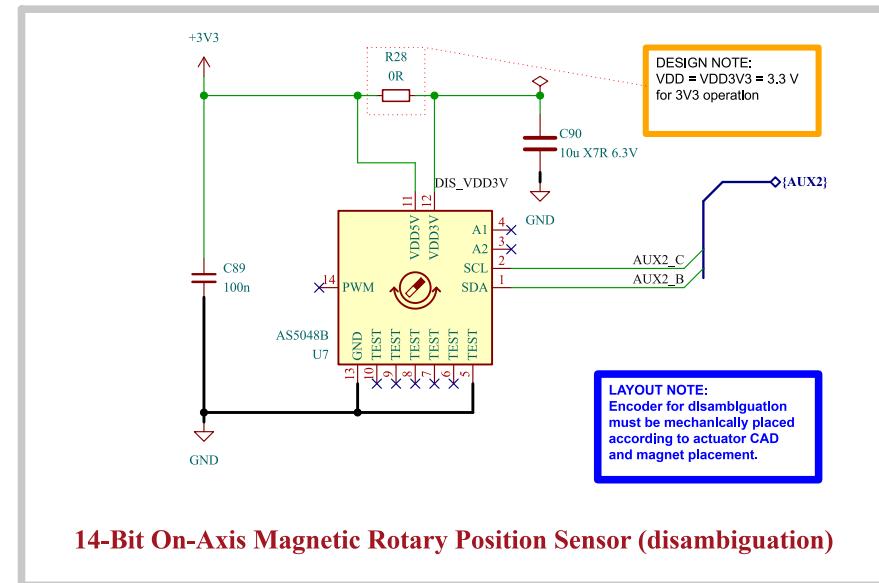
EPFL XploreSheet: /Project Architecture/Sensing - Battery/
File: BatterySensing.kicad_sch**Title: Battery Sensing Voltage Divider**Size: A4 | Date: 2023-10-14
KiCad E.D.A. kicad 7.0.6Rev: 1.0
Id: 13/21

[14] Sensing - Position



14-Bit On-Axis Magnetic Rotary Position Sensor (commutation)

DESIGN NOTE:
AS5047P senses magnet mounted on planetary sun gear, for commutation.
AS5048B senses magnet mounted on shaft with same reduction factor as planetary gearbox for disambiguation.



14-Bit On-Axis Magnetic Rotary Position Sensor (disambiguation)

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Sensing - Position/
File: PositionSensors.kicad_sch

Title: Onboard Position Sensors

Size: A4 Date: 2023-10-14

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 14/21

[15] Interface - RS-422

A

B

C

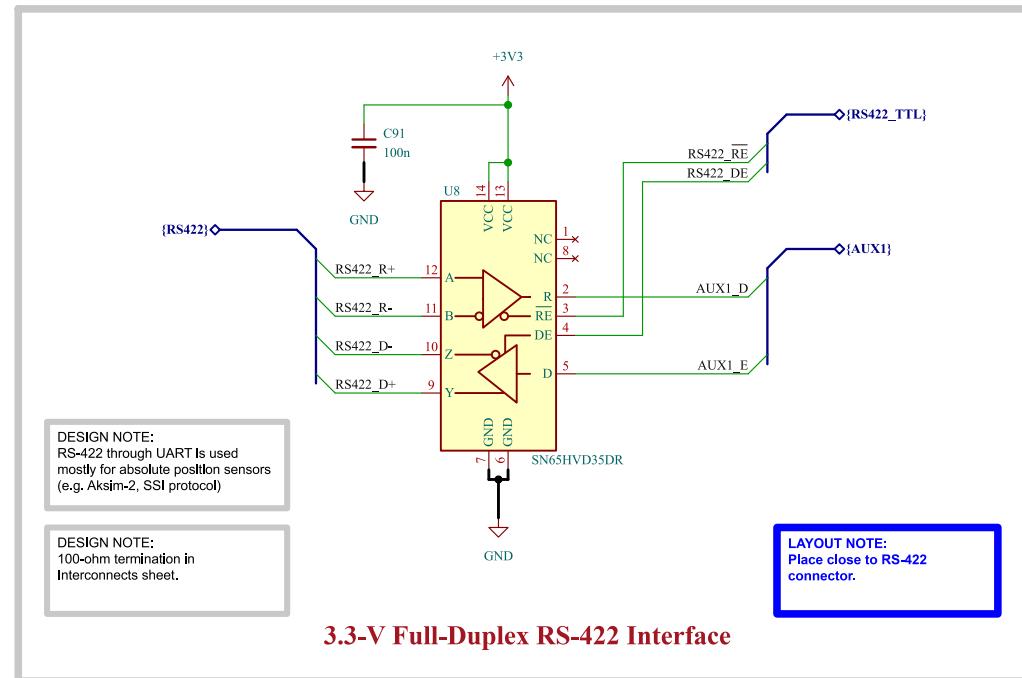
D

A

B

C

D



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Interface - RS-422/
File: RS422Interface.kicad_sch

Title: RS-422 Interface

| | |
|--------------------------|------------------|
| Size: A4 | Date: 2023-10-15 |
| KiCad E.D.A. kicad 7.0.6 | |

| |
|-----------|
| Rev: 1.0 |
| Id: 15/21 |

[16] Interface - FD-CAN

A

B

C

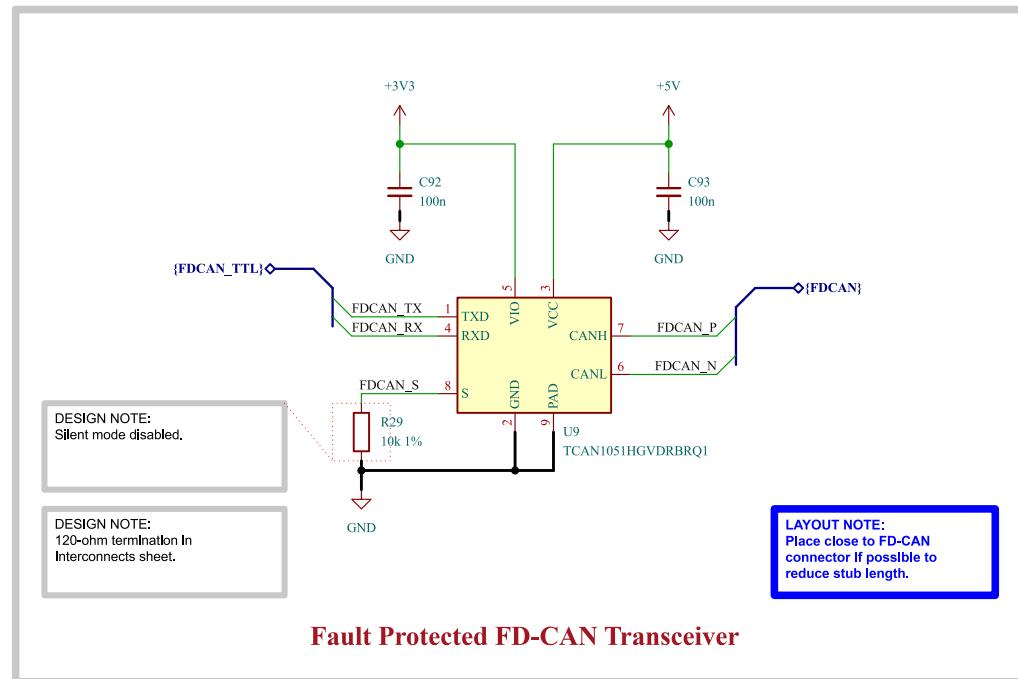
D

A

B

C

D



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Interface - FD-CAN/
File: FDCANTransceiver.kicad_sch

Title: FD-CAN Transceiver

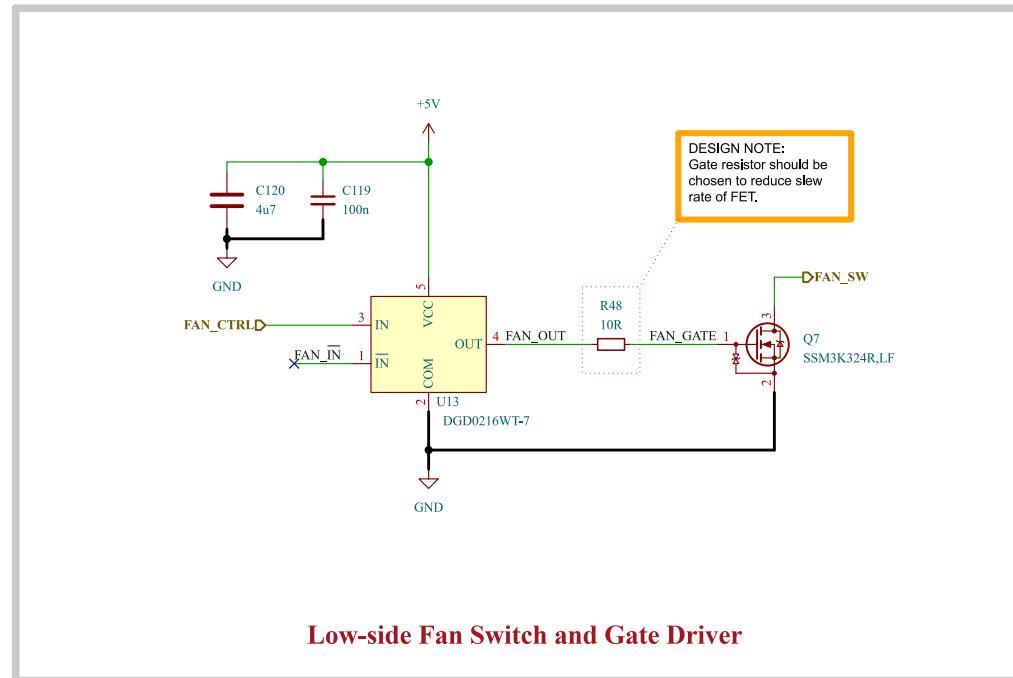
Size: A4 Date: 2023-10-15

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 16/21

[17] Interface - Fan Control



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Interface - Fan Control/
File: FanControl.kicad_sch

Title: Low-side Fan Switch

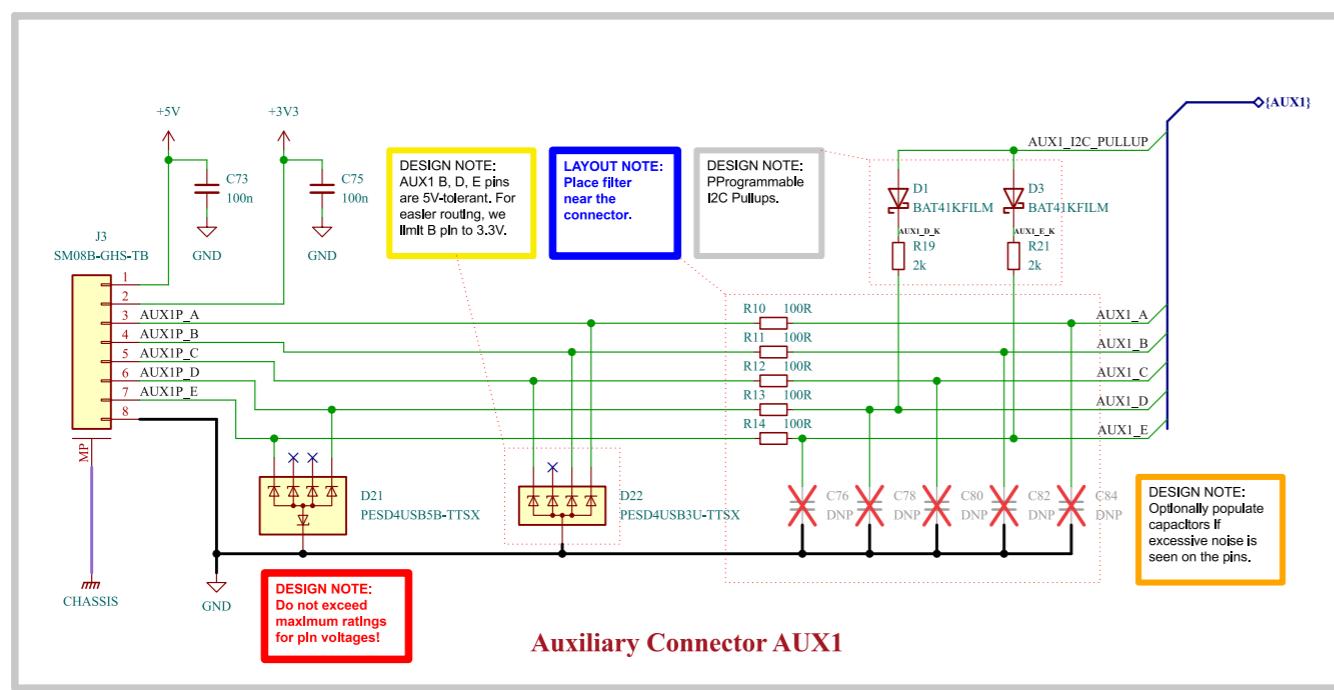
Size: A4 Date: 2023-11-19

KiCad E.D.A. kicad 7.0.6

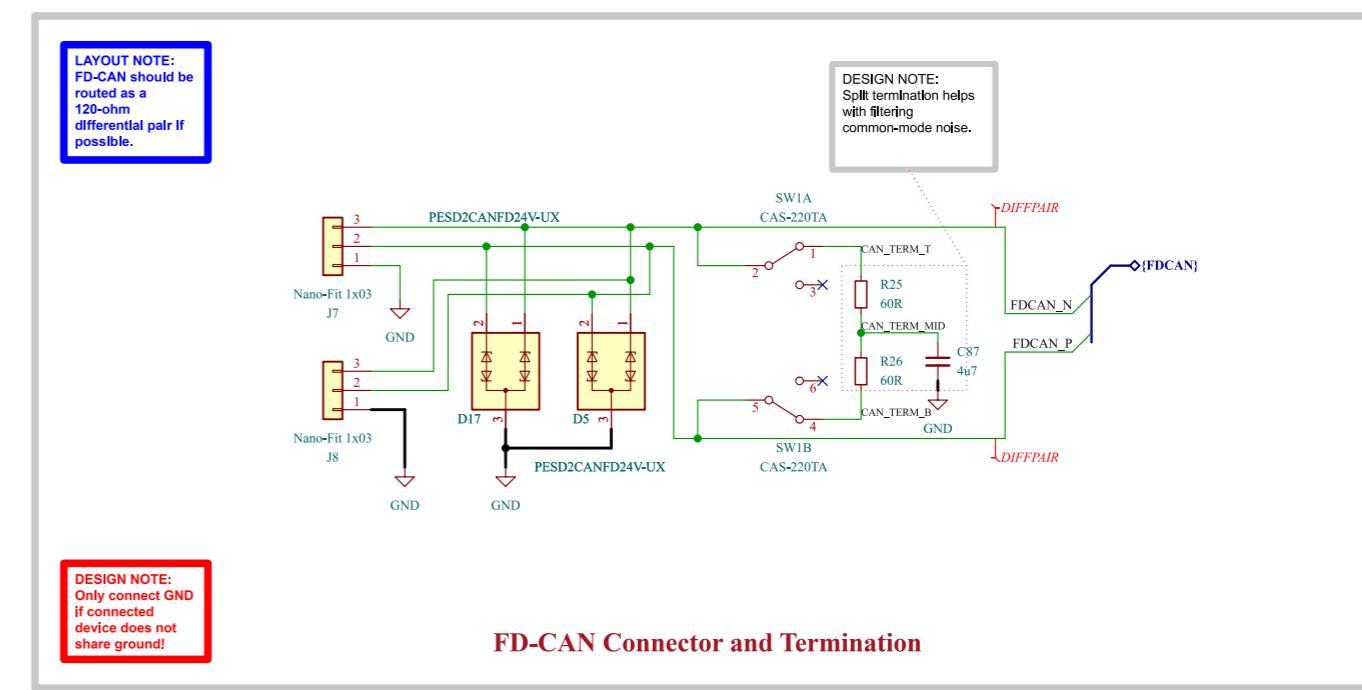
Rev: 1.0

Id: 17/21

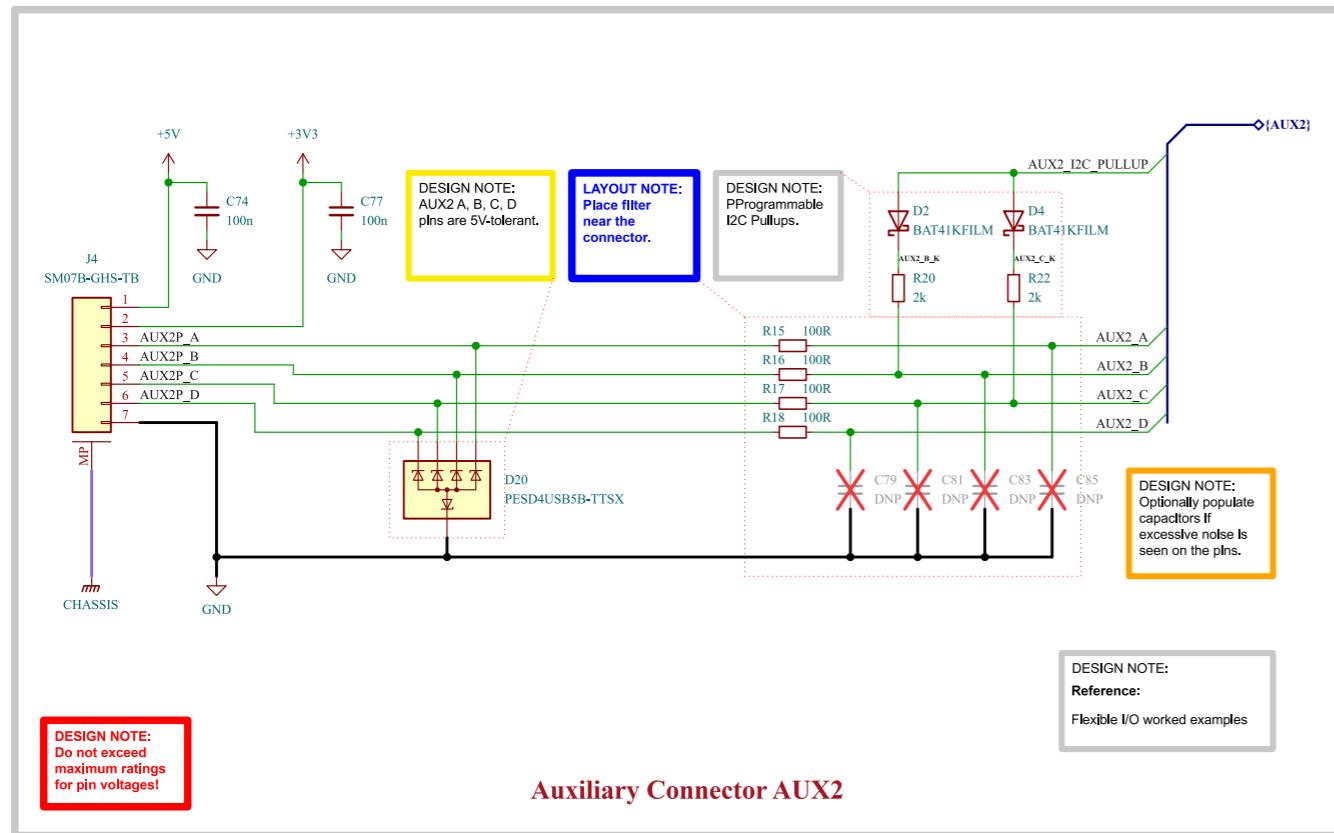
[18] Interface - Interconnects



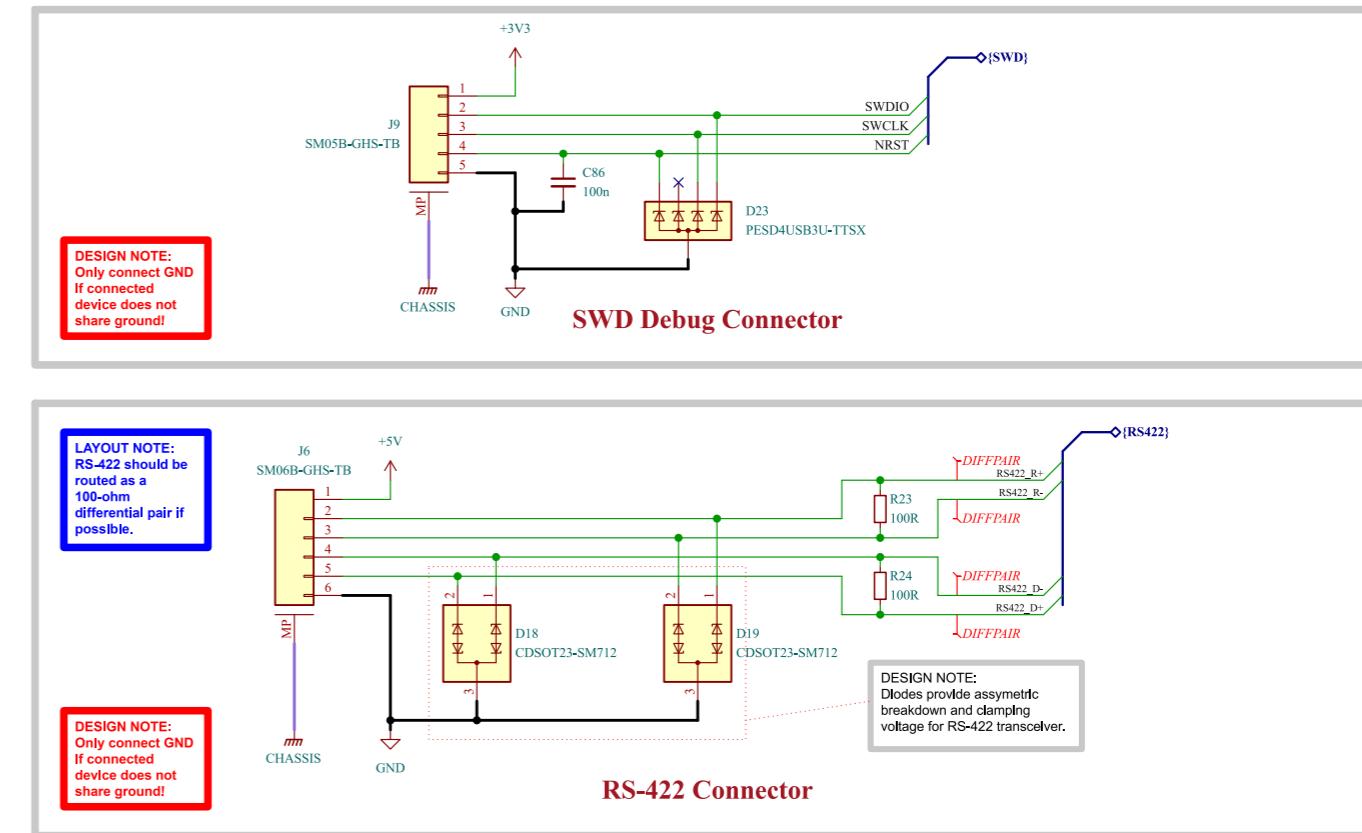
Auxiliary Connector AUX1



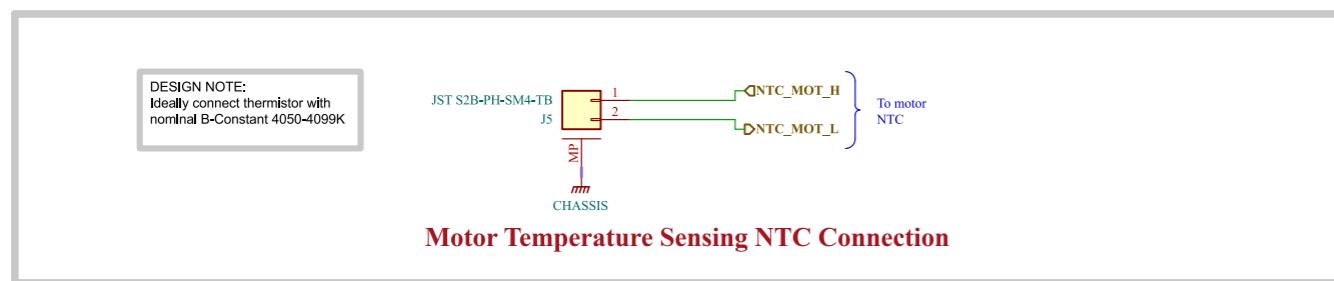
FD-CAN Connector and Termination



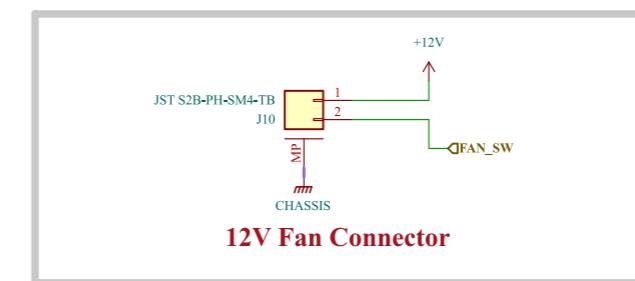
Auxiliary Connector AUX2



SWD Debug Connector



Motor Temperature Sensing NTC Connection



12V Fan Connector

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Interface - Interconnects/
File: Interconnects.kicad_sch

Title: Interconnects

Size: A3 Date: 2023-10-14
KiCad E.D.A. kicad 7.0.6

Rev: 1.0
Id: 18/21

[19] Mechanical - Holes

A

A

B

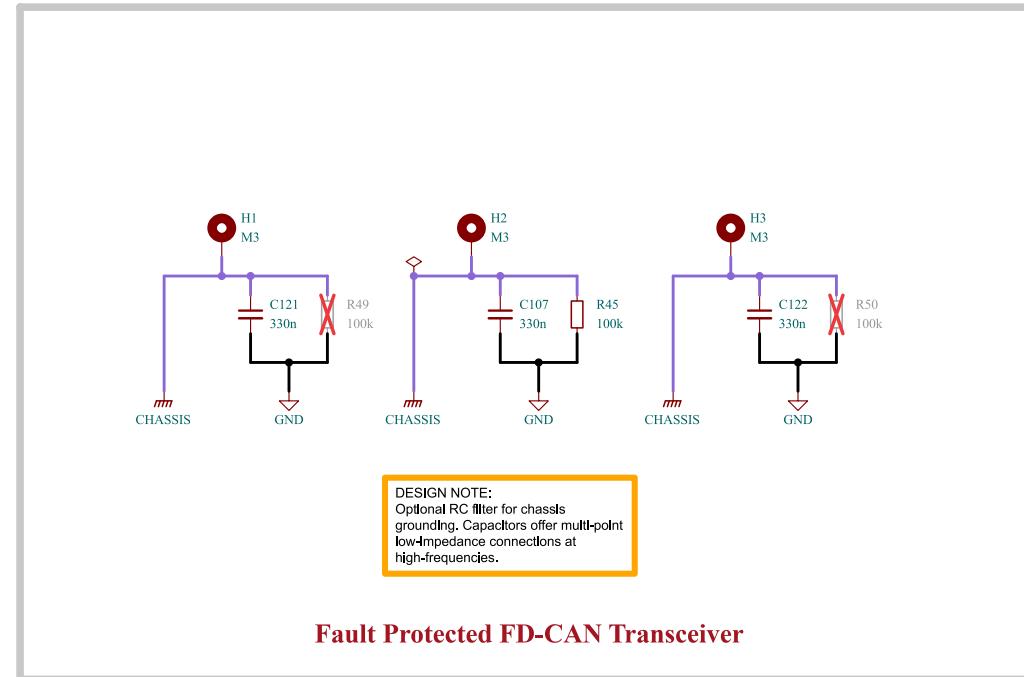
B

C

C

D

D



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Mechanical - Holes/
File: Mechanical.kicad_sch**Title: Mechanical Parts**Size: A4 Date: 2023-10-22
KiCad E.D.A. kicad 7.0.6Rev: 1.0
Id: 19/21

[20] Power Sequencing

A

B

C

D

A

B

C

D

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Power Sequencing/

File: PowerSequencing.kicad_sch

Title: Power Sequencing

Size: A4 Date:

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 20/21

[21] Revision History

A Rev 1.0

- Changed CPH-CPL capacitor to 47nF (gate driver)
- Changed FD-CAN transceiver IC
- Added TVS protection and termination switch to FD-CAN
- Added low-side switched 12V 600mA source for external fan
- Added LDO for analog supply
- Changed input power TVS diode to bidirectional and added one diode per connector

- Moved SOx low-pass filter to MCU section.
Should be placed near MCU to avoid noise coupling into ADC lines.

- Added second onboard I2C magnetic encoder for disambiguation.
- Switched PWM_PHASEA with PWM_PHASEC on STM32G474 pinout for easier routing.
- Changed RS422 pinout on connector
- Added ESD protection to all interfaces
- Added overvoltage protection on thermistor ADC inputs

C D Author: Vincent Nguyen

EPFL XploreSheet: /Revision History/
File: RevisionHistory.kicad_sch**Title: Revision History**Size: A4 Date: 2023-10-15
KiCad E.D.A. kicad 7.0.6Rev: 1.0
Id: 21/21