

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.

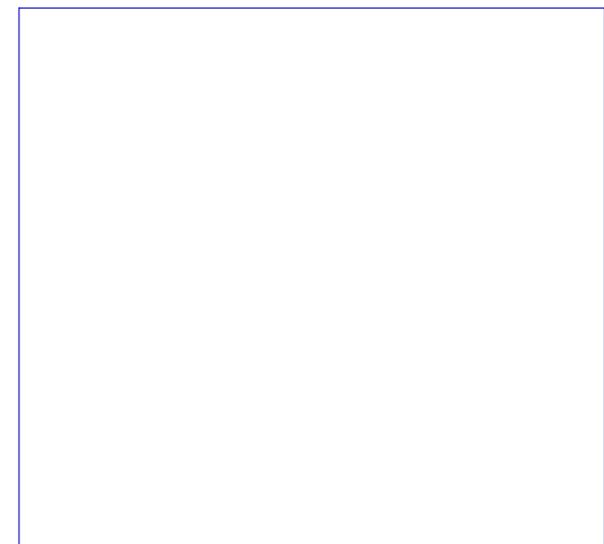
DESIGN NOTE:  
Example text for critical design notes.

LAYOUT NOTE:  
Example text for critical layout guidelines.

## TOP VIEW



## BOTTOM VIEW



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

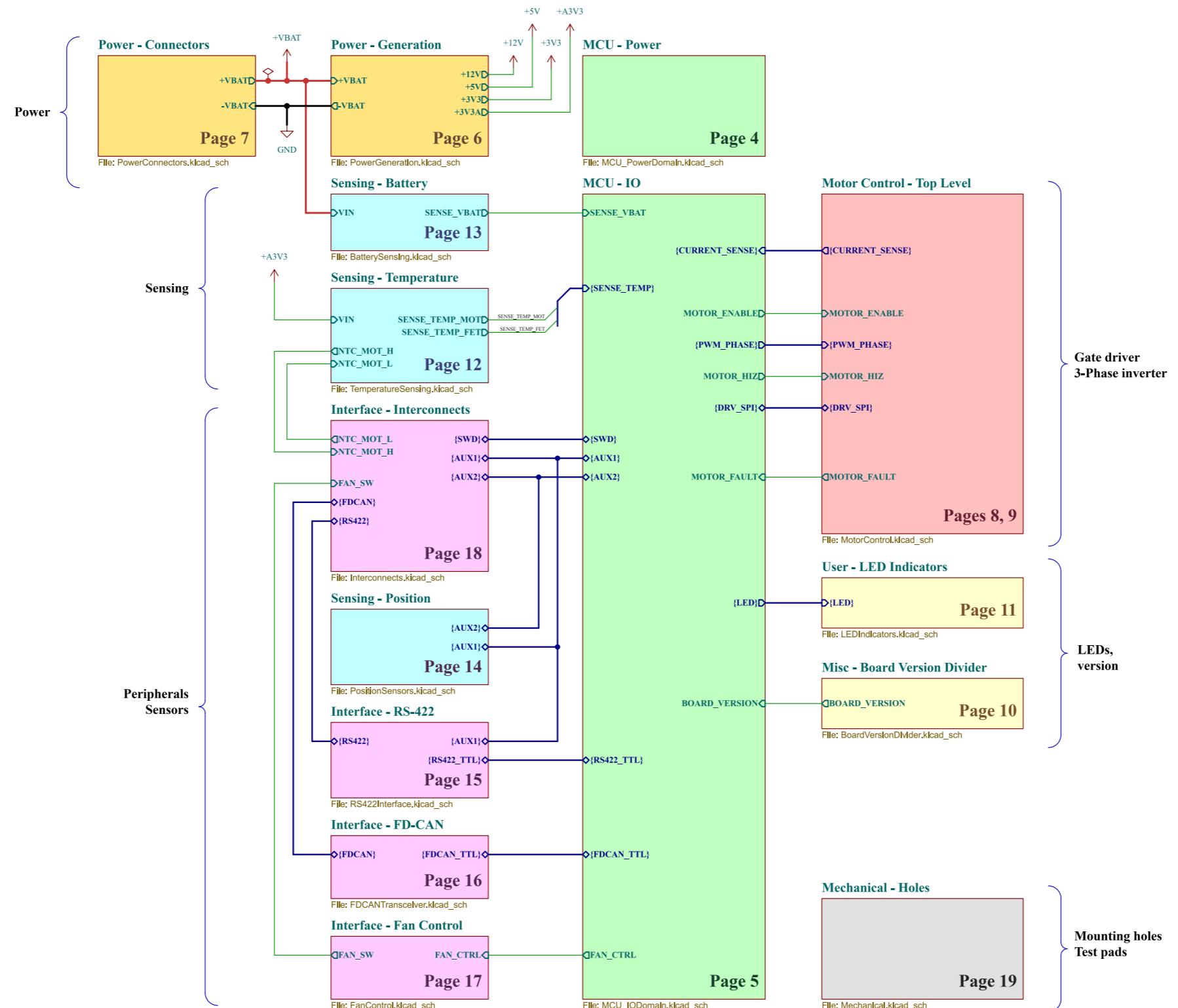
**Title:**

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
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## [4] MCU - Power

A

B

C

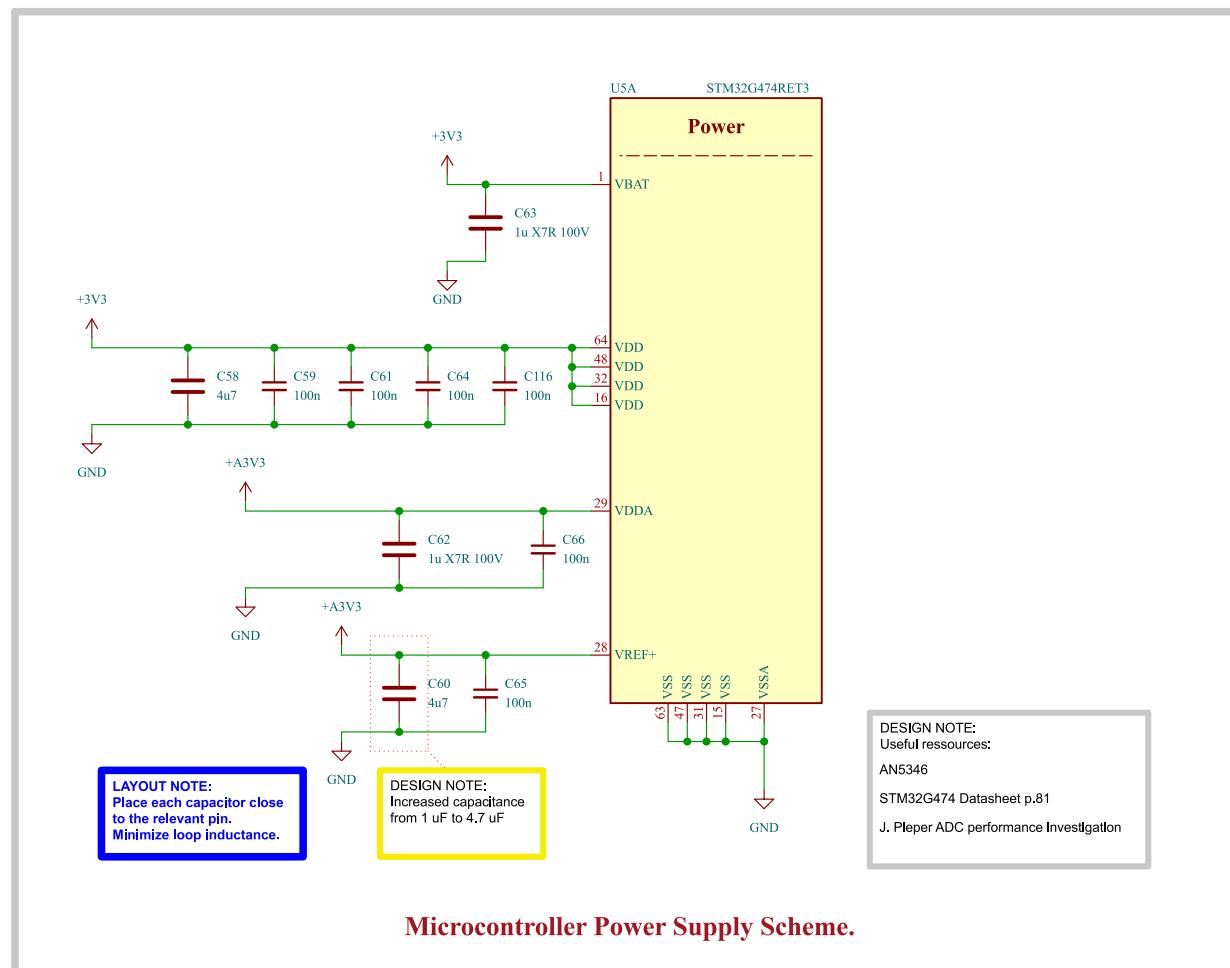
D

A

B

C

D



Microcontroller Power Supply Scheme.

Author: Vincent Nguyen

EPFL Xplore

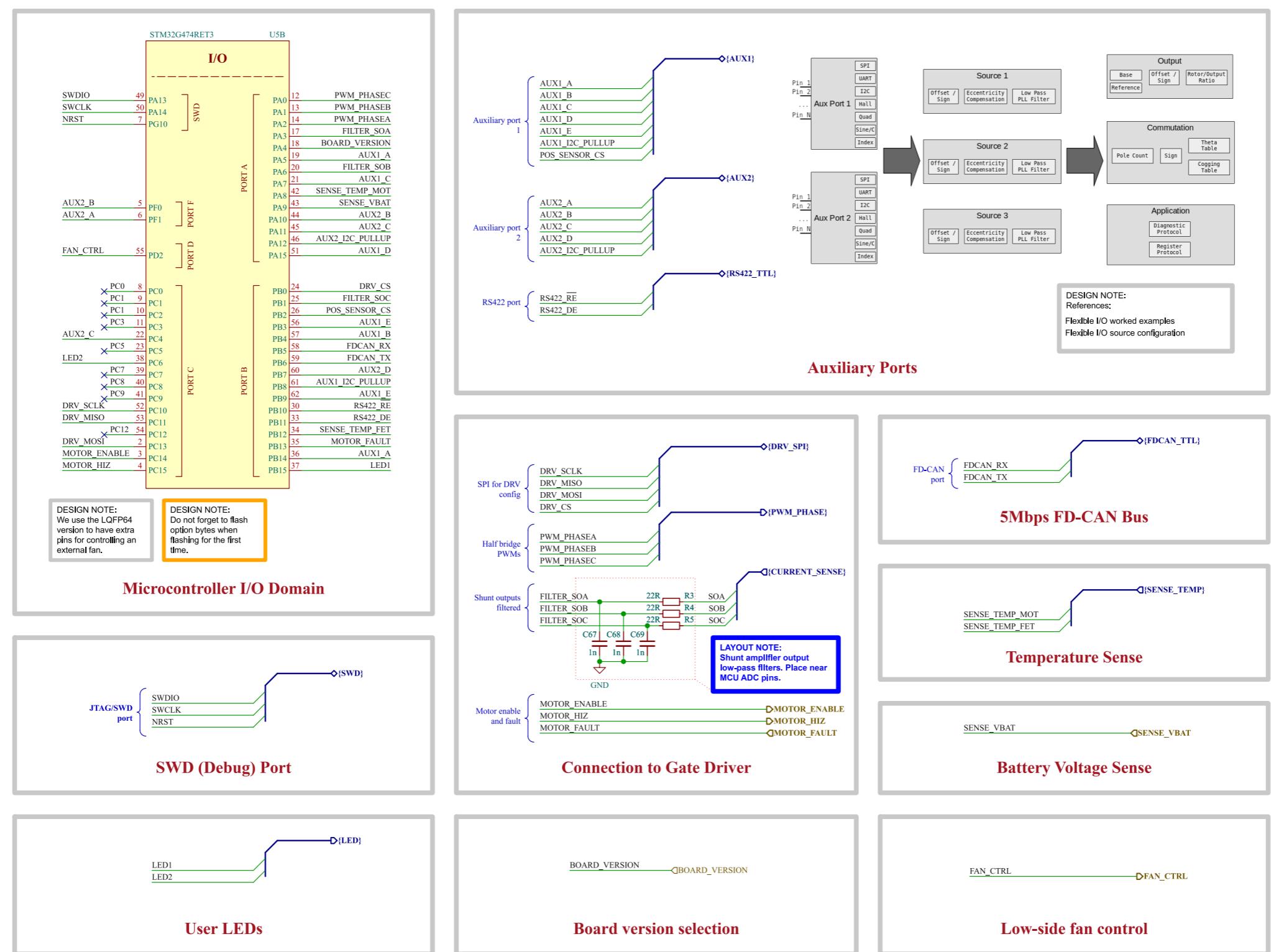
Sheet: /Project Architecture/MCU - Power/  
File: MCU\_PowerDomain.kicad\_sch

**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**

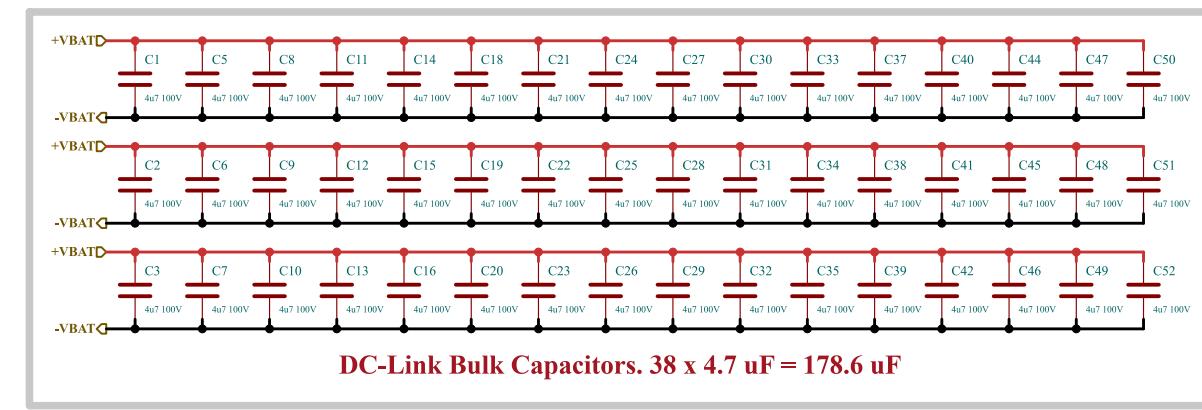
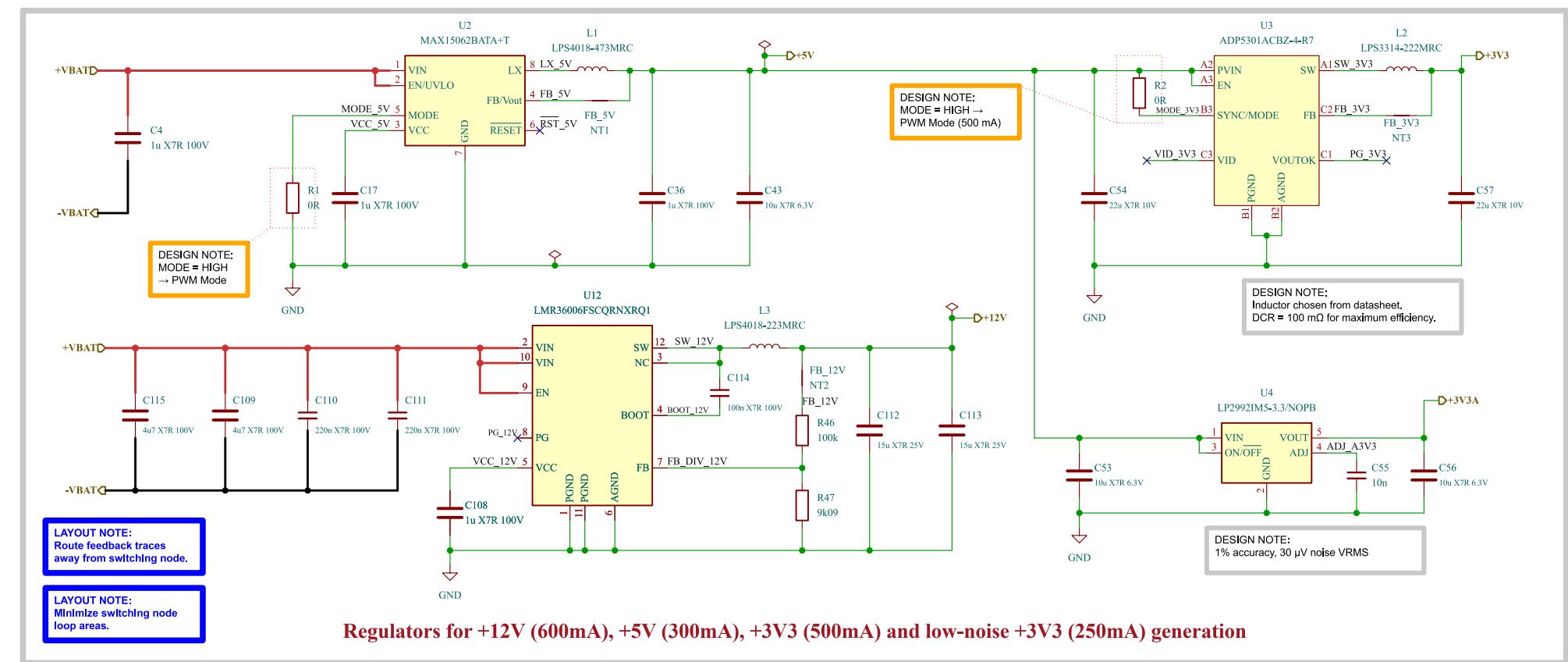
Size: A3 Date: 2023-10-14

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 5/21

# [6] Power - Generation



**DESIGN NOTE:**  
Bulk capacitors might introduce a large inrush current. An external precharge circuit is advised to charge the bulk capacitors.

**DESIGN NOTE:**  
Do not exceed absolute maximum ratings! Maximum Input voltage is 54V.

Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Power - Generation/  
File: PowerGeneration.kicad\_sch

**Title: Power Generation**

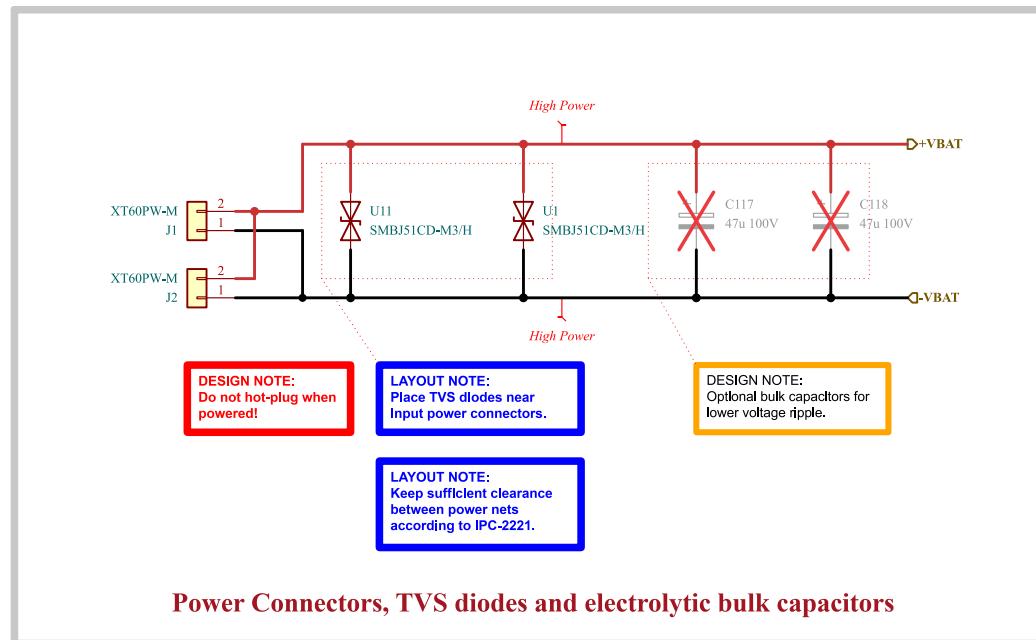
Size: A4 Date: 2023-10-21

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 6/21

# [7] Power - Connectors



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Power - Connectors/  
File: PowerConnectors.kicad\_sch

**Title: Power Connectors**

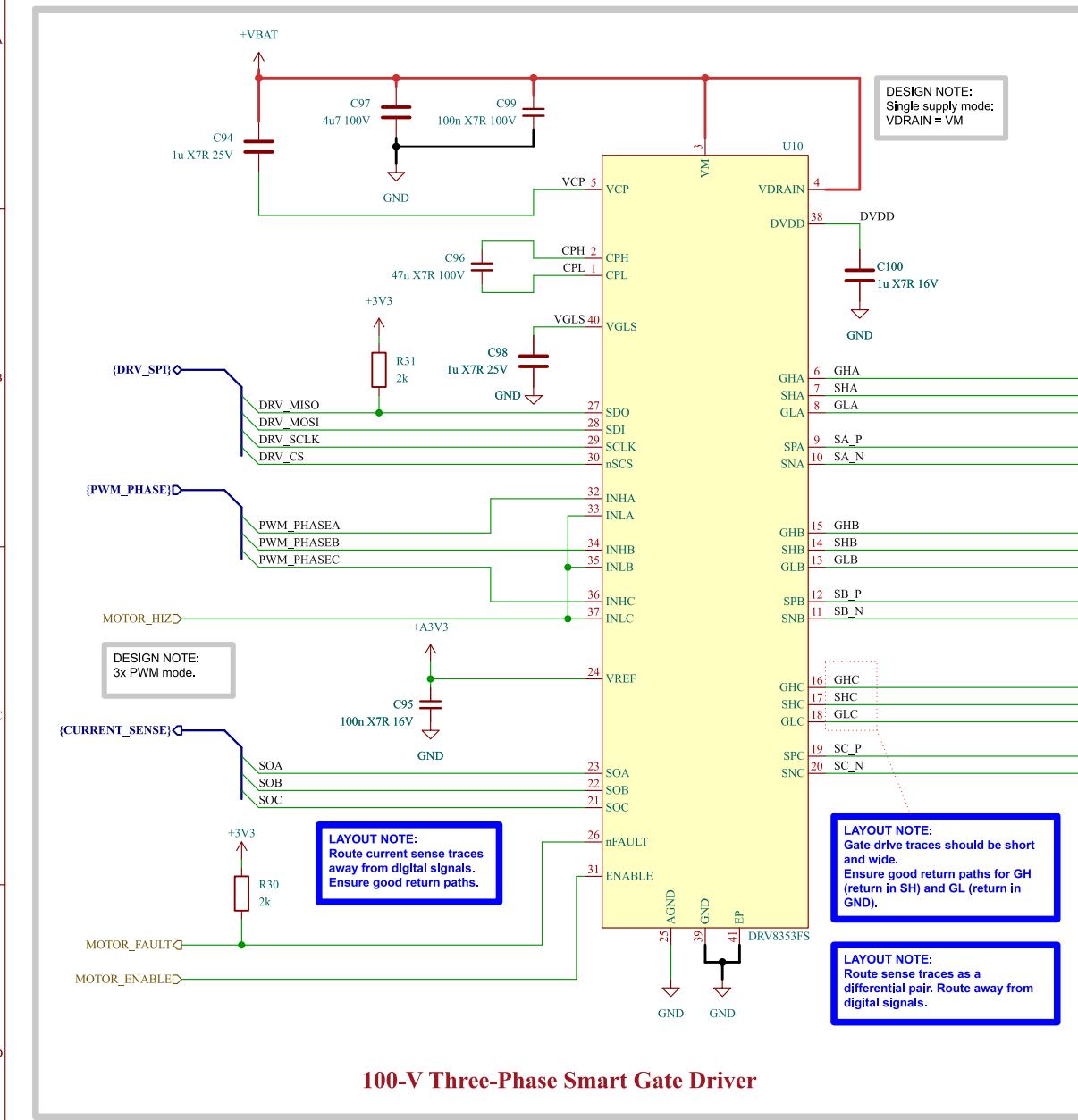
Size: A4 Date: 2023-10-14

KiCad E.D.A. kicad 7.0.6

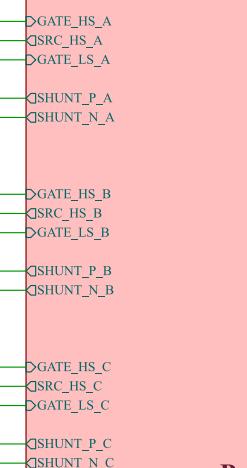
Rev: 1.0

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**

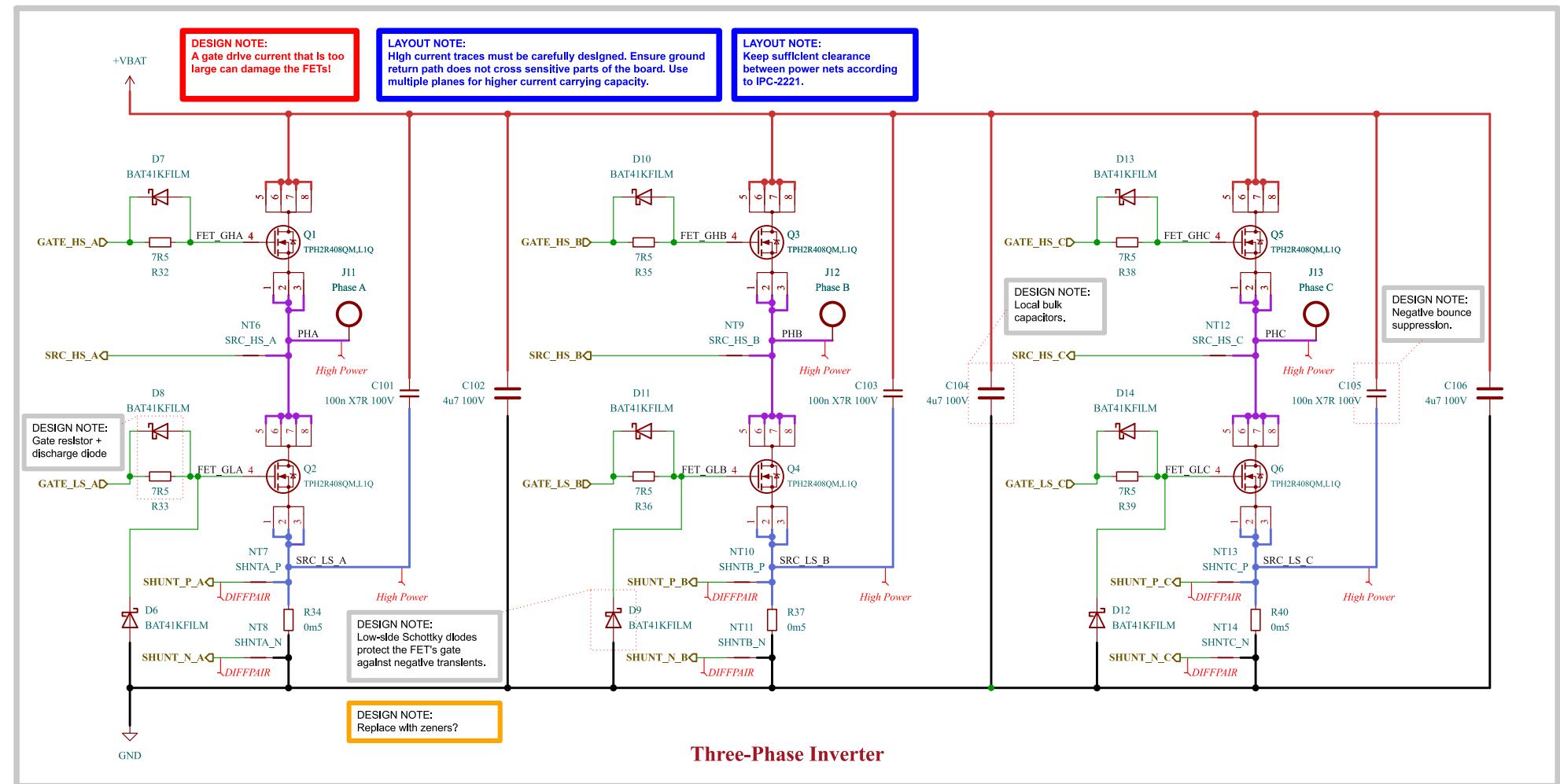
Size: A4 Date: 2023-10-16

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**

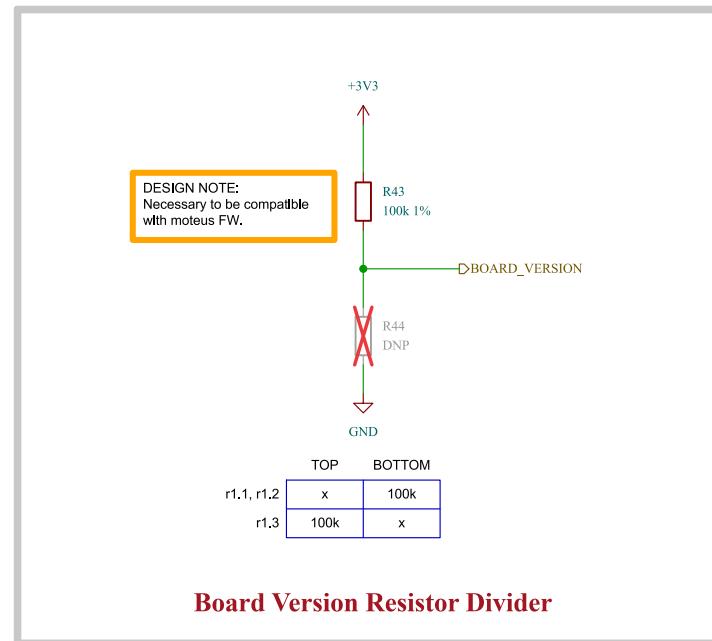
Size: A4 Date: 2023-10-18

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 7.0.6Rev: 1.0  
Id: 10/21

# [11] User - LED Indicators

A

B

C

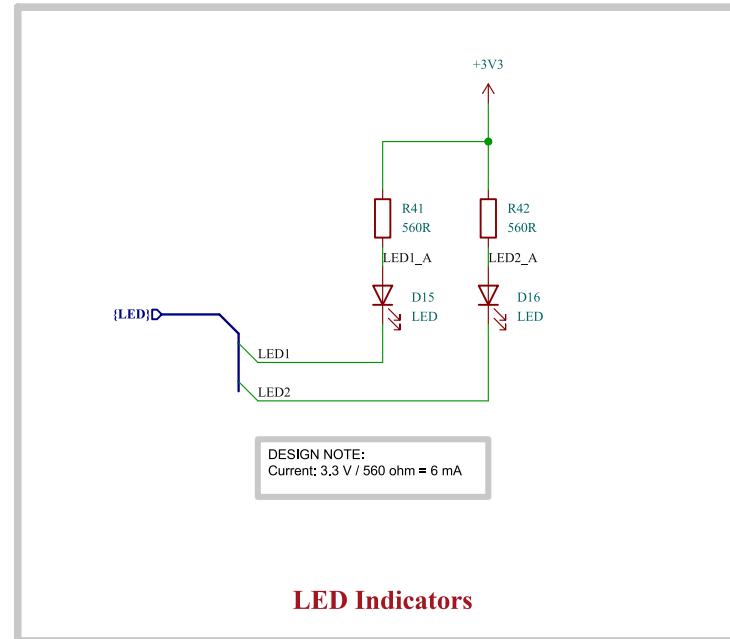
D

A

B

C

D



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 7.0.6Rev: 1.0  
Id: 11/21

# [12] Sensing - Temperature

A

B

C

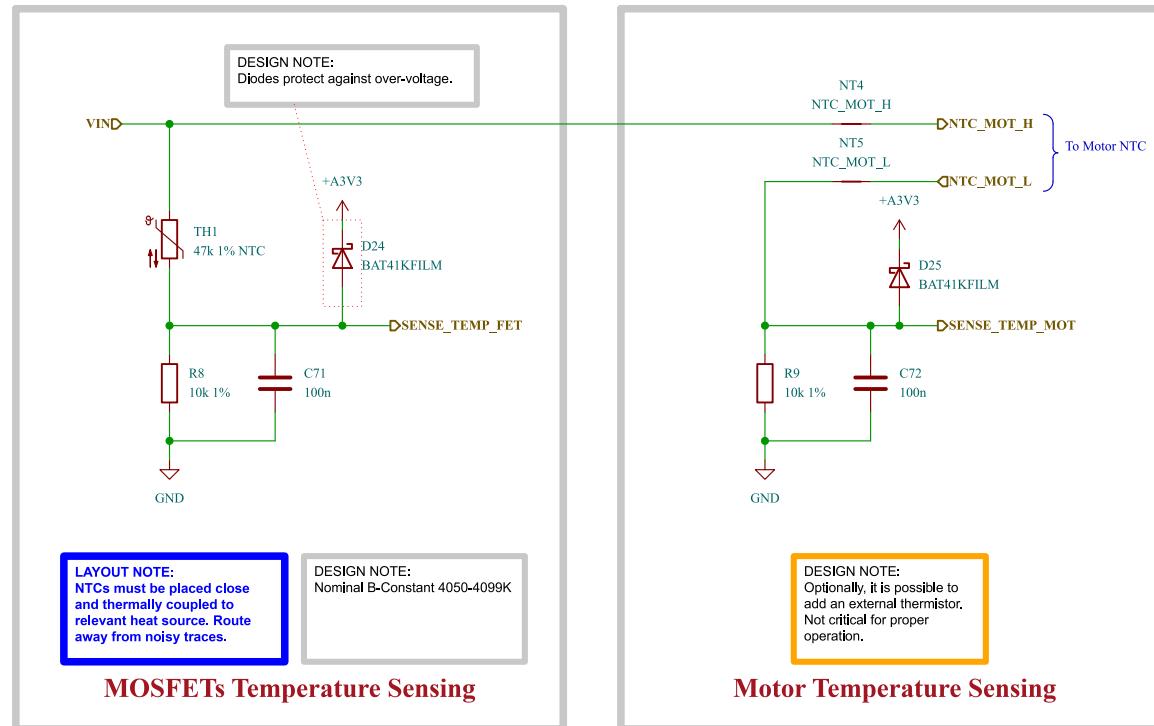
D

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

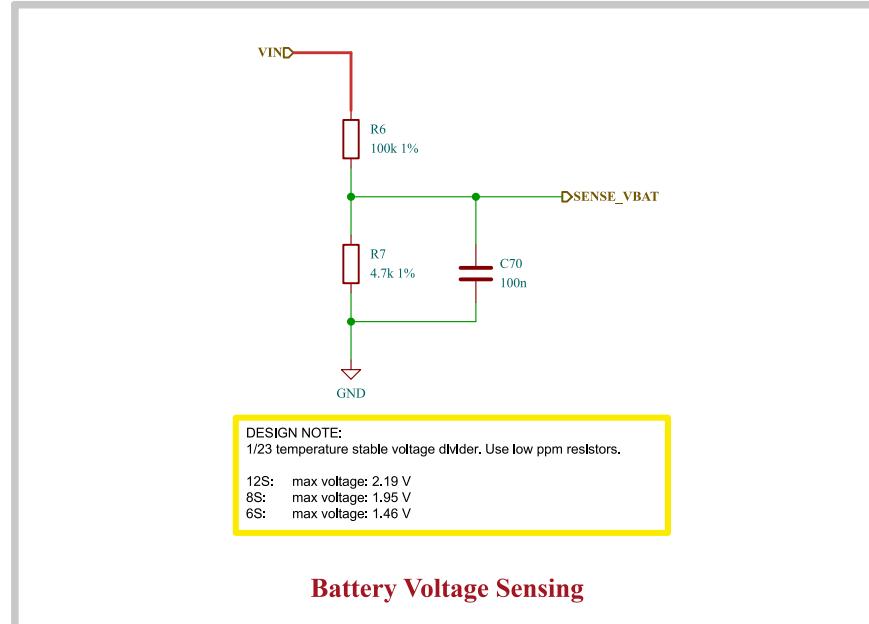
D

A

B

C

D

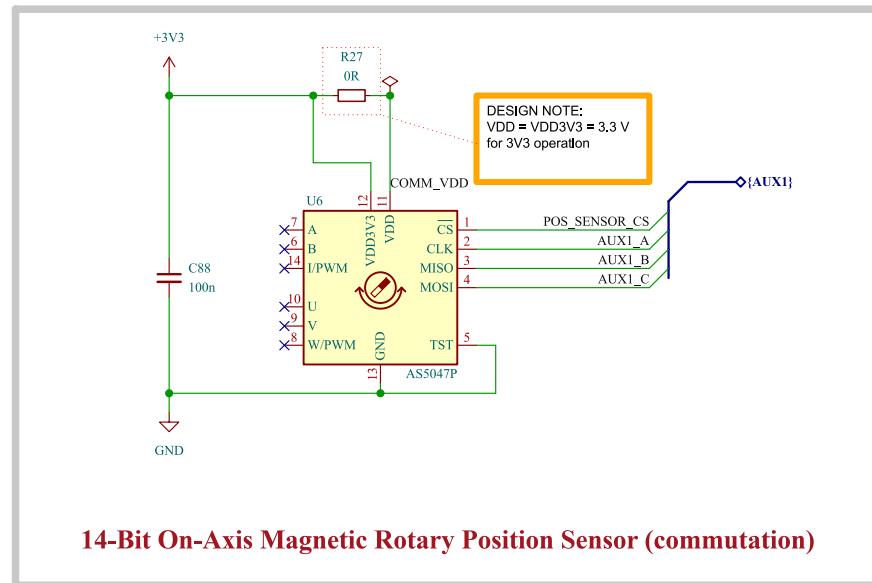


Author: Vincent Nguyen

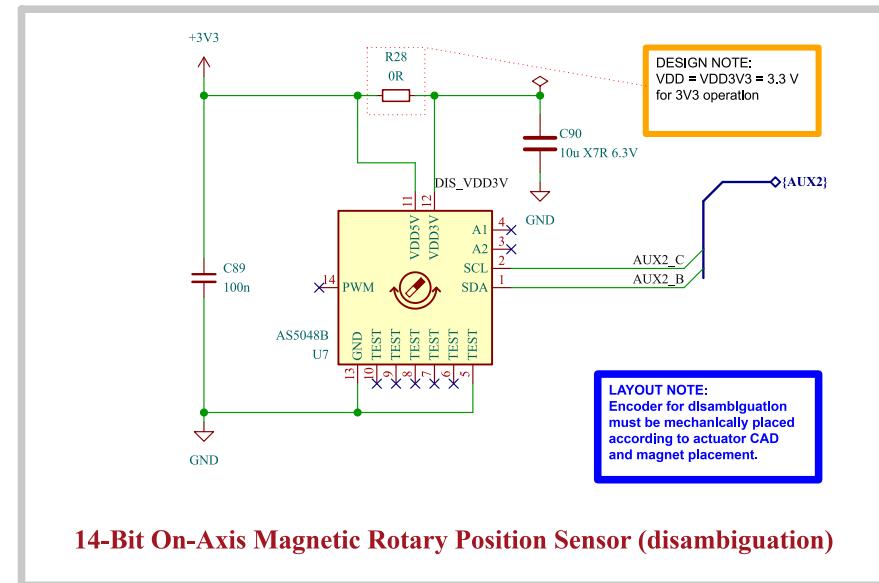
EPFL Xplore

Sheet: /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



**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.



**DESIGN NOTE:**  
The encoder for disambiguation cannot be used to estimate backlash!

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

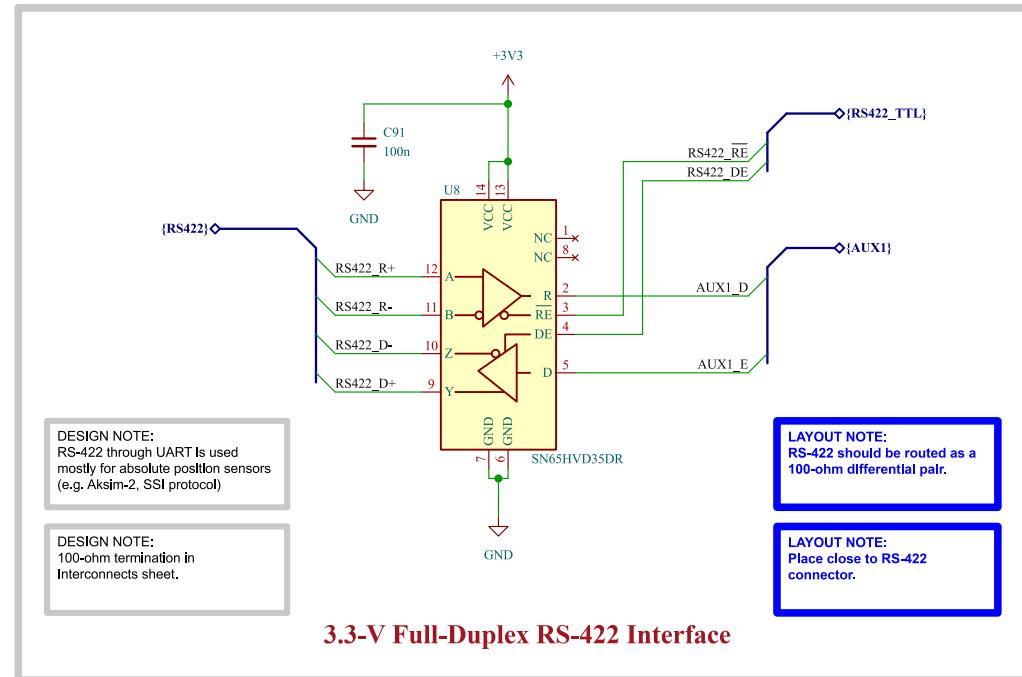
D

A

B

C

D



Author: Vincent Nguyen

EPFL Xplore

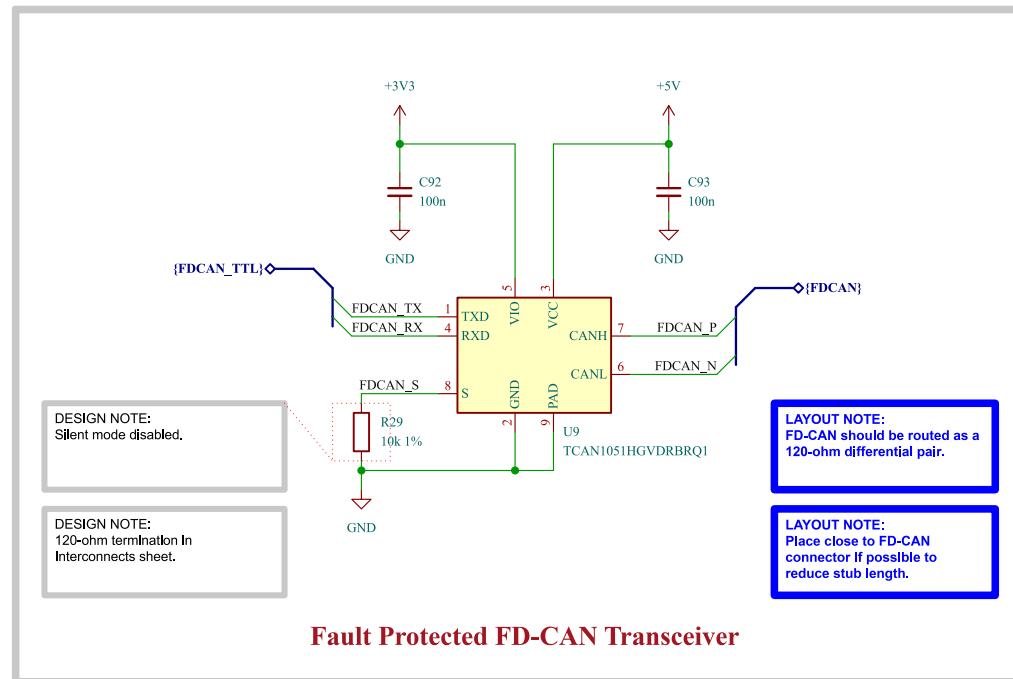
Sheet: /Project Architecture/Interface - RS-422/  
File: RS422Interface.kicad\_sch

**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



Author: Vincent Nguyen

EPFL Xplore

Sheet: /Project Architecture/Interface - FD-CAN/  
File: FDCANTransceiver.kicad\_sch

**Title: FD-CAN Transceiver**

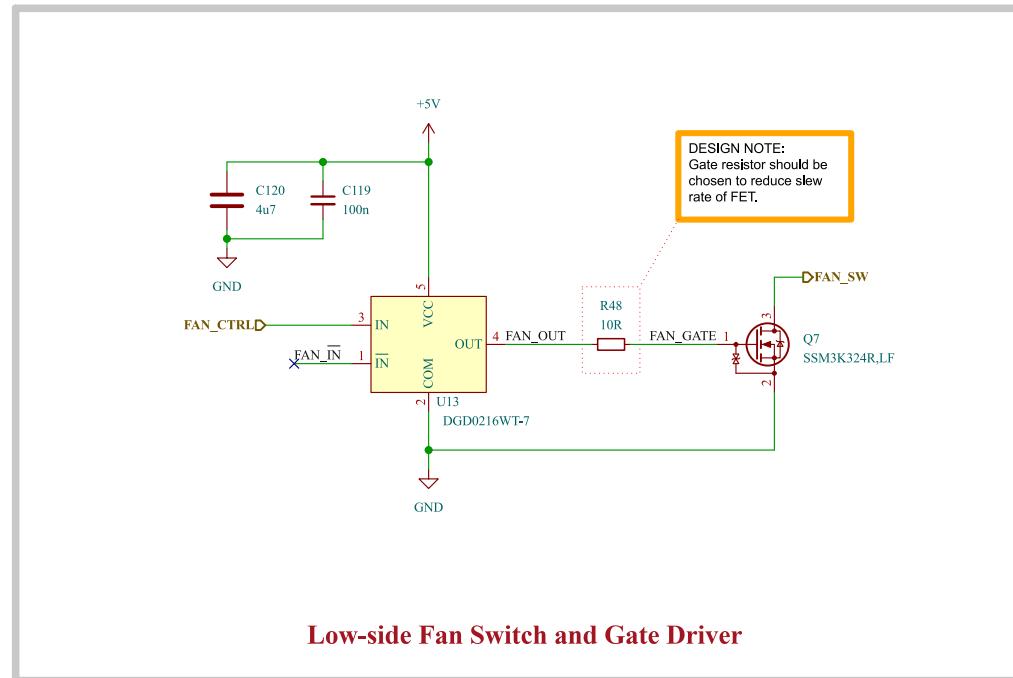
Size: A4 Date: 2023-10-15

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**

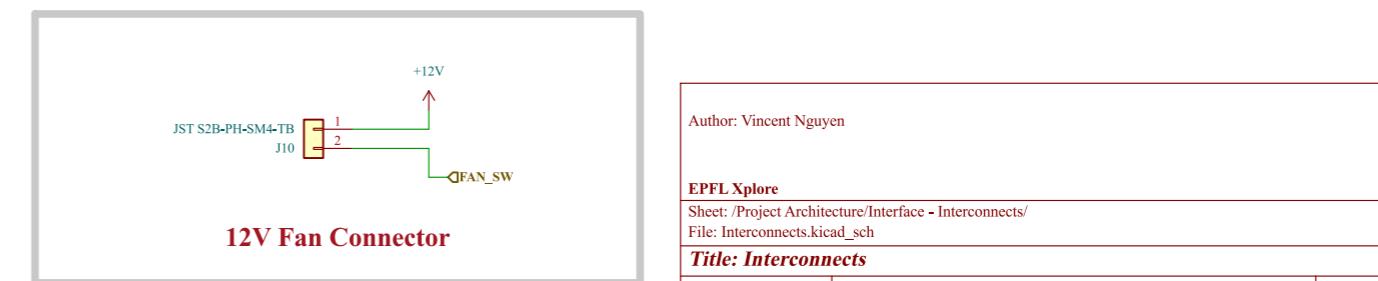
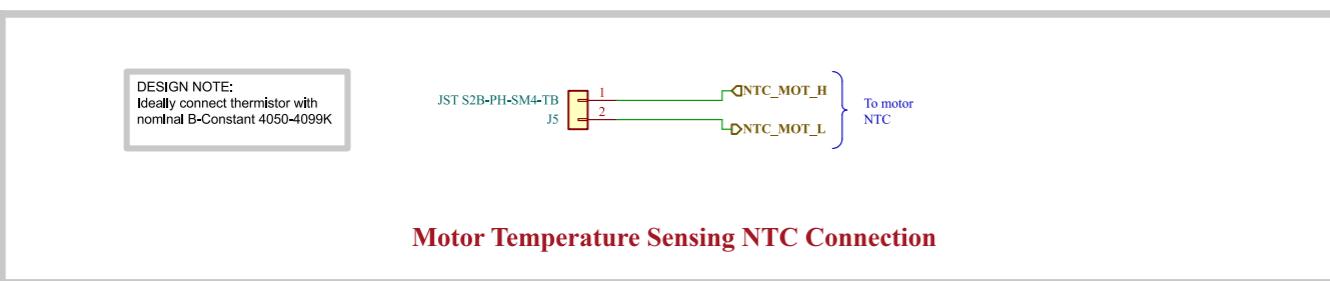
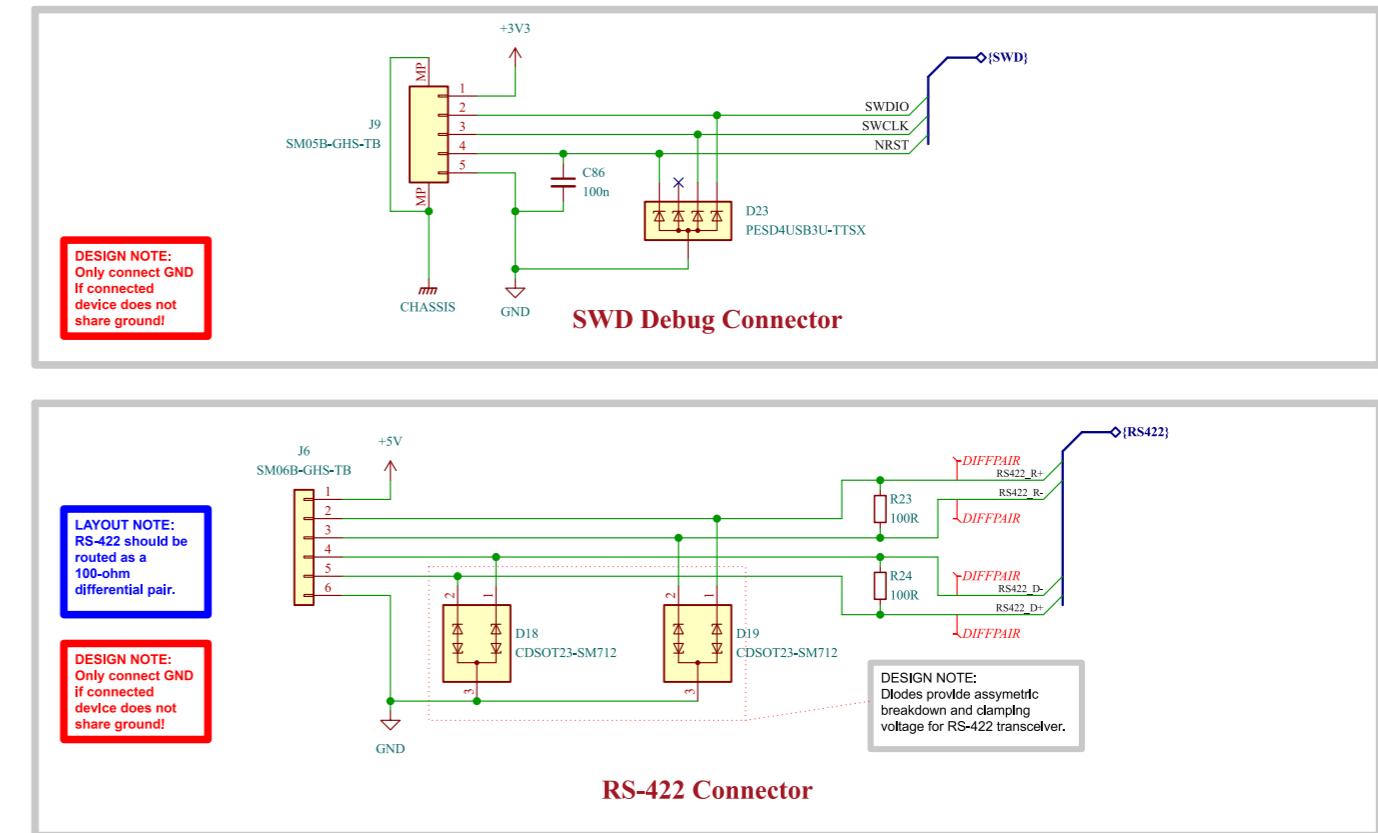
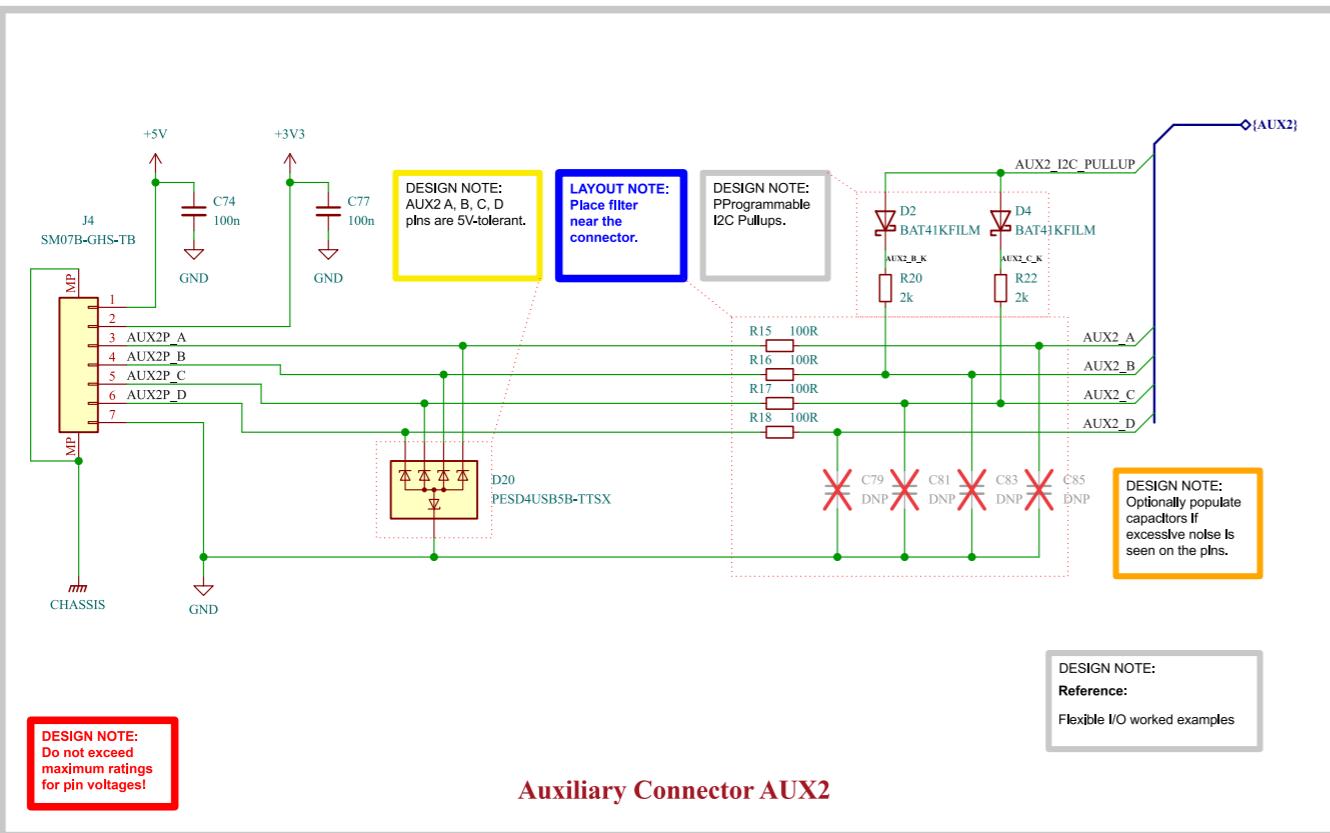
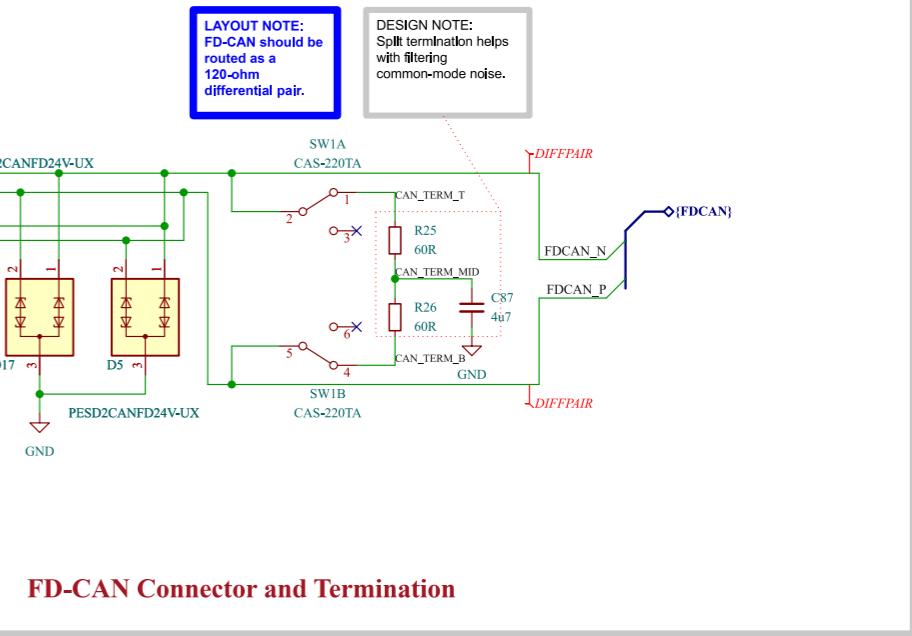
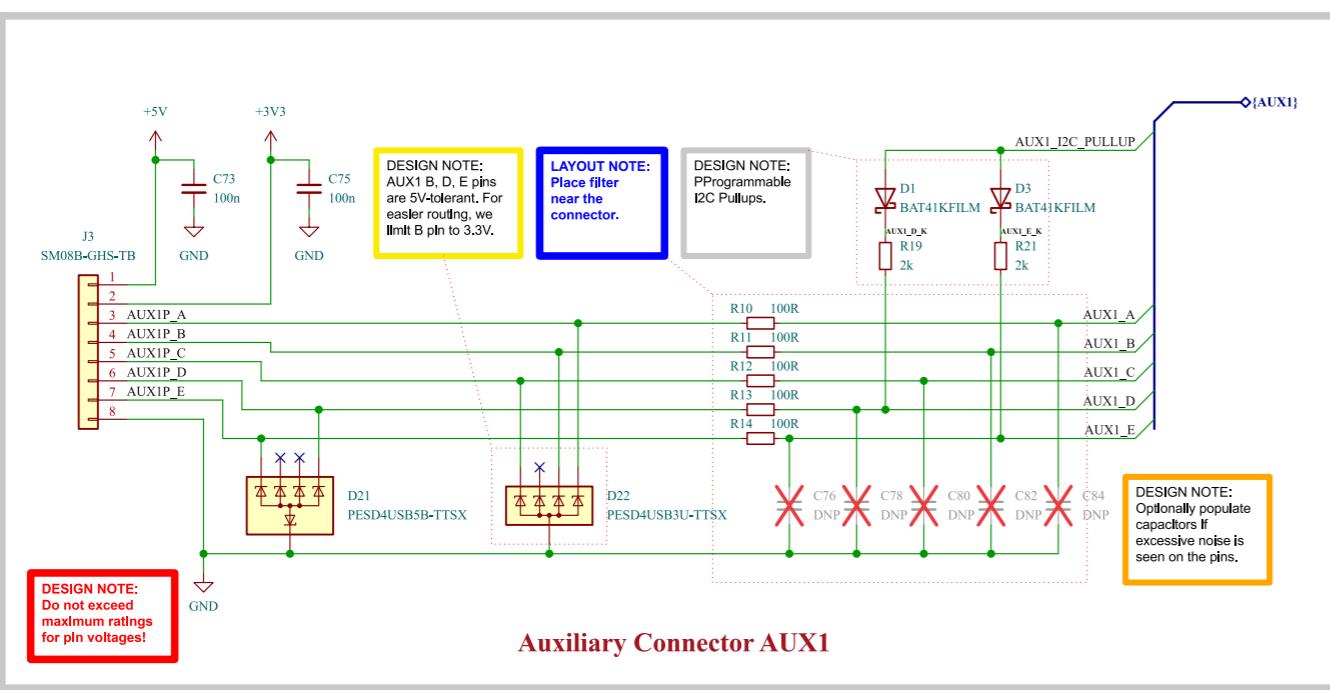
Size: A4 Date: 2023-11-19

KiCad E.D.A. kicad 7.0.6

Rev: 1.0

Id: 17/21

# [18] Interface - Interconnects



# [19] Mechanical - Holes

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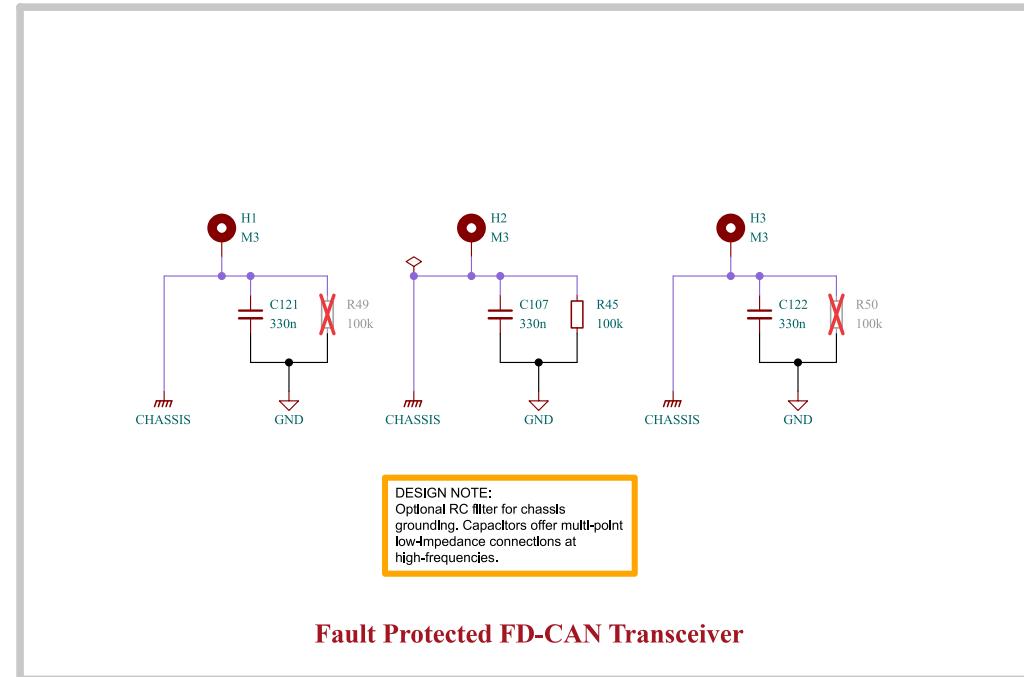
D

A

B

C

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 Xplore

Sheet: /Revision History/  
File: RevisionHistory.kicad\_sch

**Title: Revision History**

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

<b>Rev: 1.0</b>
Id: 21/21