

# Amulet Motion Controller

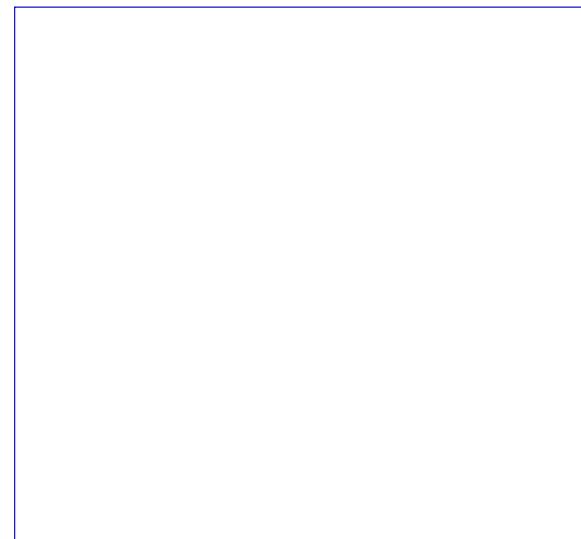
## Variant: Preliminary

2023-12-17

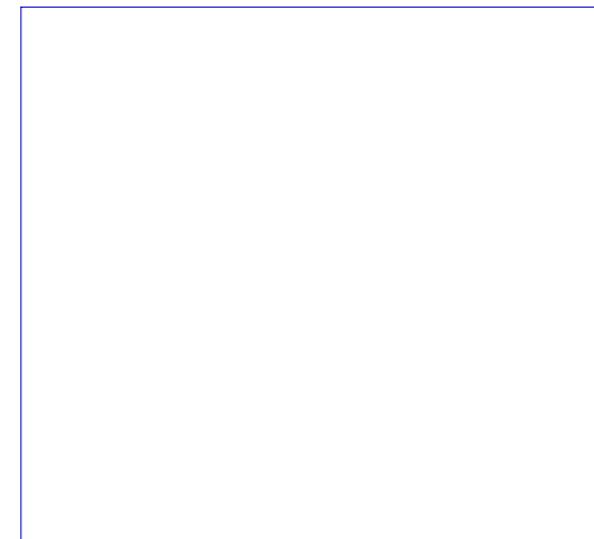
Rev 1.0

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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. Contact the engineer if you find any.

RELEASED - A board with this schematic has been sent to production.

Preliminary XX.XX.XX

## DESIGN CONSIDERATIONS

DESIGN NOTE:  
Example text for informational design notes.

DESIGN NOTE:  
Example text for debug notes.

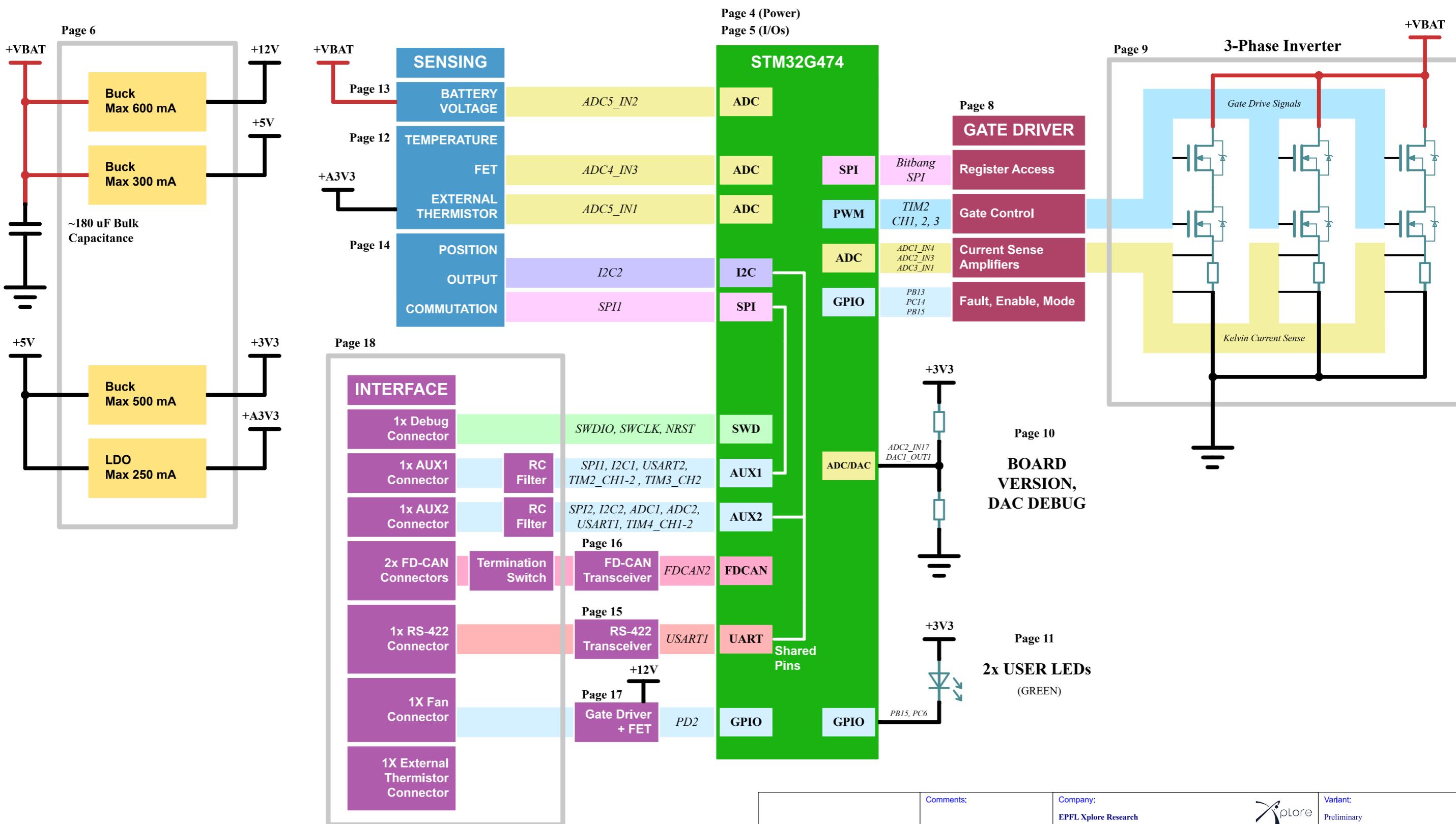
DESIGN NOTE:  
Example text for cautionary design notes.

DESIGN NOTE:  
Example text for critical design notes.

LAYOUT NOTE:  
Example text for critical layout guidelines.

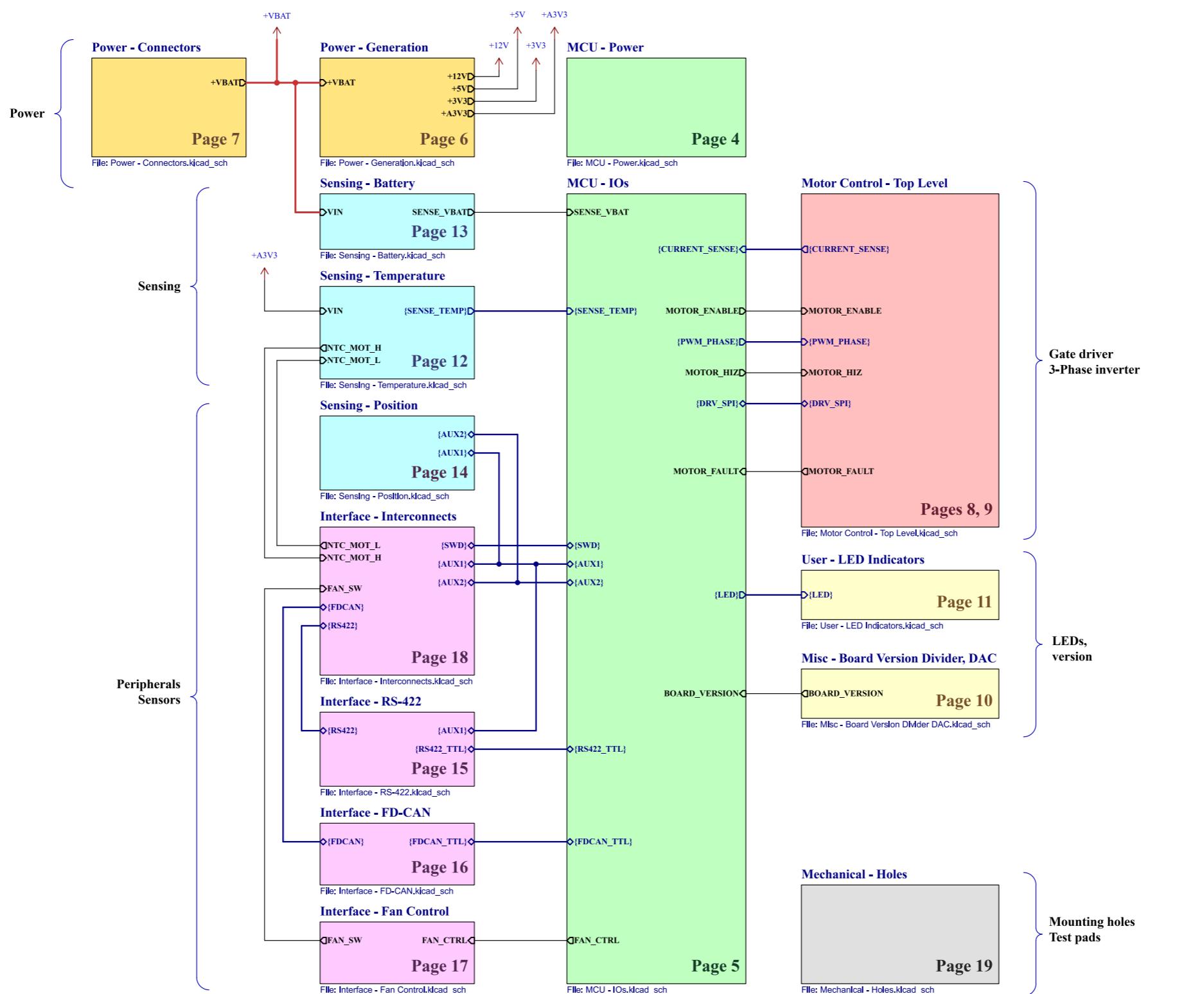
	Comments:	Company: EPFL Xplore Research	Variant: Preliminary
		Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzée</b>
	Sheet Title: Cover Page	File Name: amulet_controller.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /	Reviewer:	Date: 2023-10-12 Revision: 1.0
		Size: A3	Sheet: 1 of 21

# [2] Block Diagram



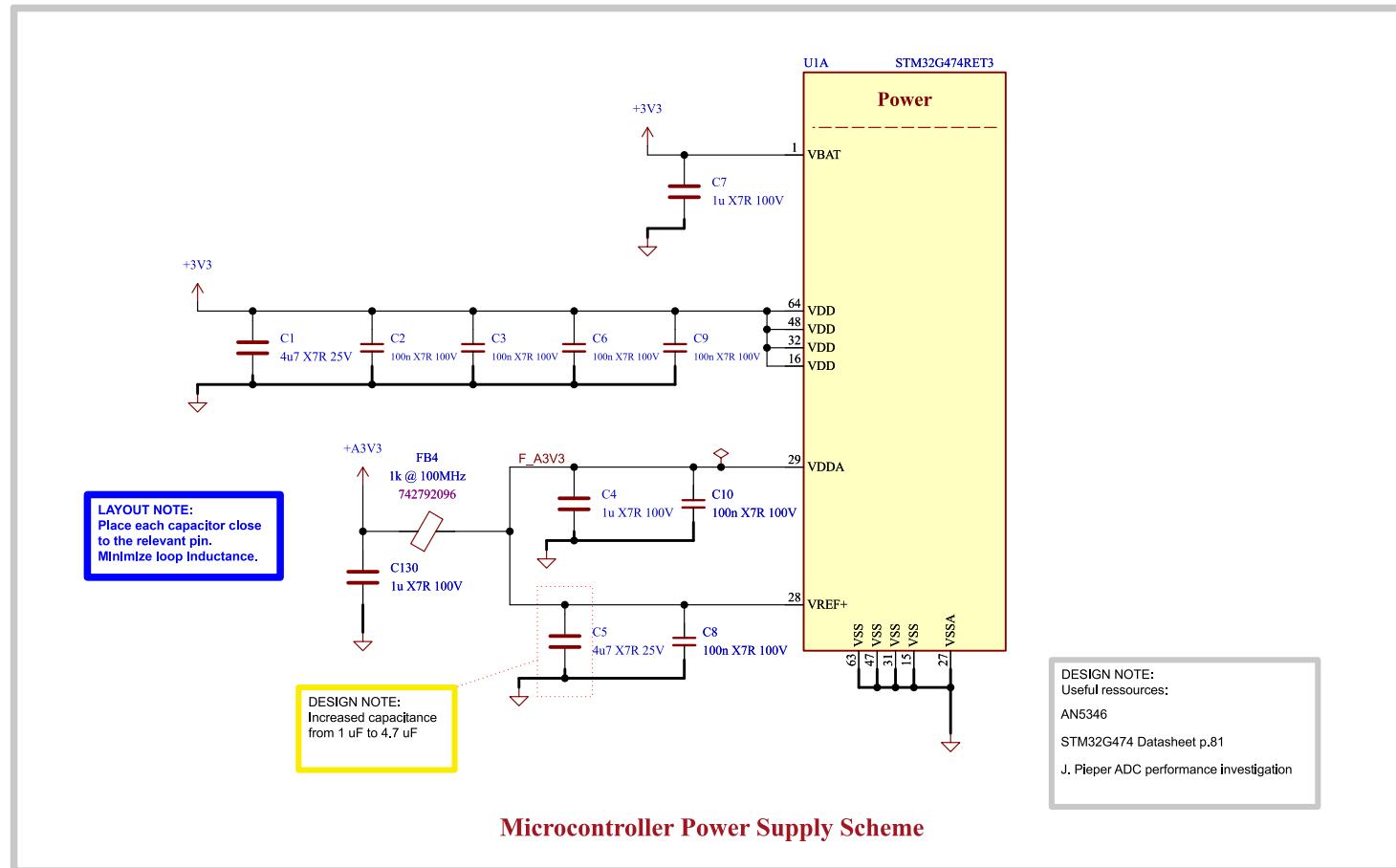
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Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzée</b>	
Sheet Title: Block Diagram	File Name: Block Diagram.kicad_sch	Designer: Vincent Nguyen
Sheet Path: /Block Diagram/	Reviewer:	Date: 2023-11-30
	Size: <b>A3</b>	Revision: 1.0
	Sheet: <b>2</b> of <b>21</b>	

# [3] Project Architecture



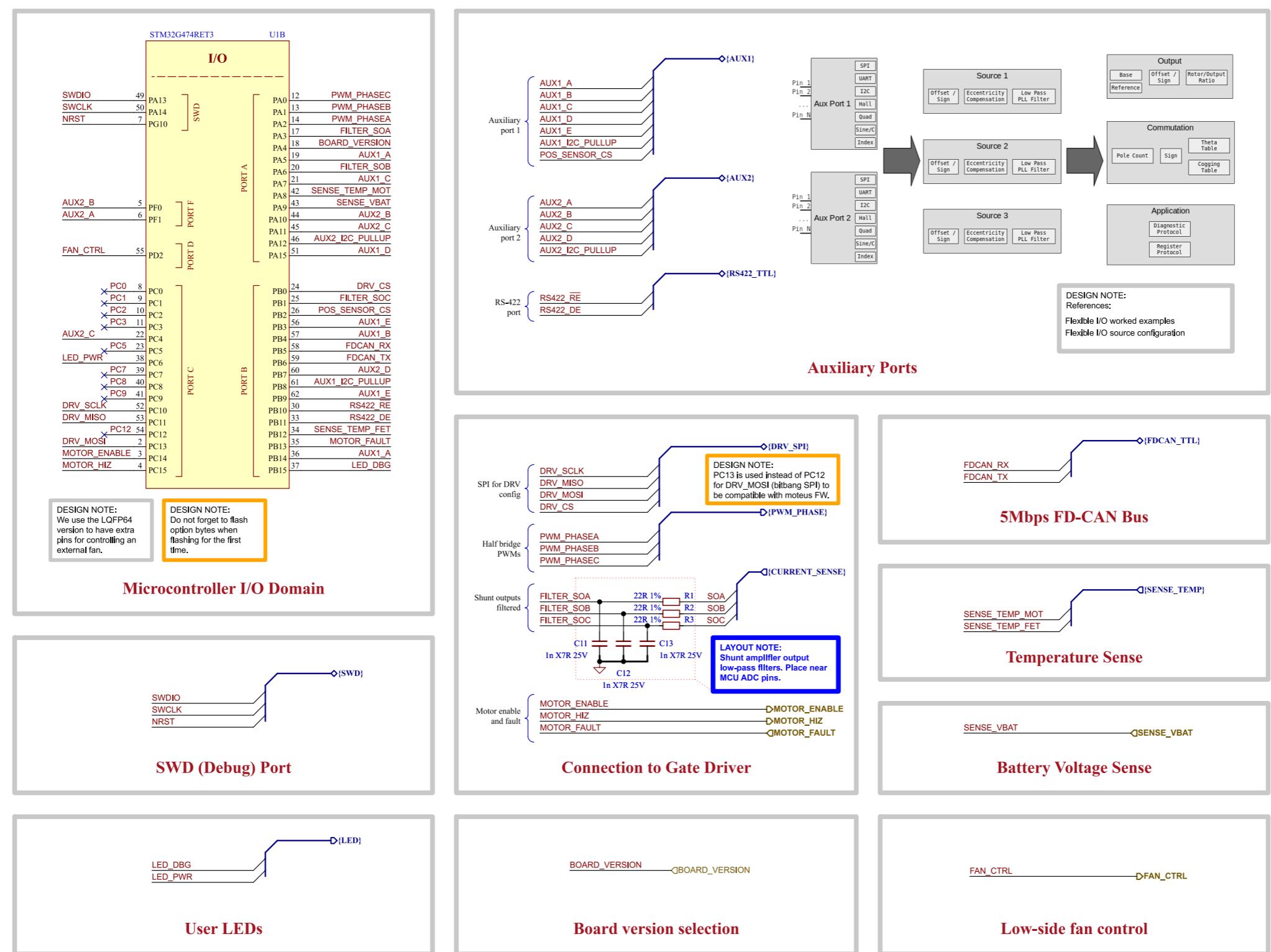
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	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzée</b>	
Sheet Title: Project Architecture	File Name: Project Architecture.kicad_sch	Designer: Vincent Nguyen	Date: 2023-11-25
Sheet Path: /Project Architecture/	Reviewer:	Size: <b>A3</b>	Revision: 1.0

# [4] MCU - Power

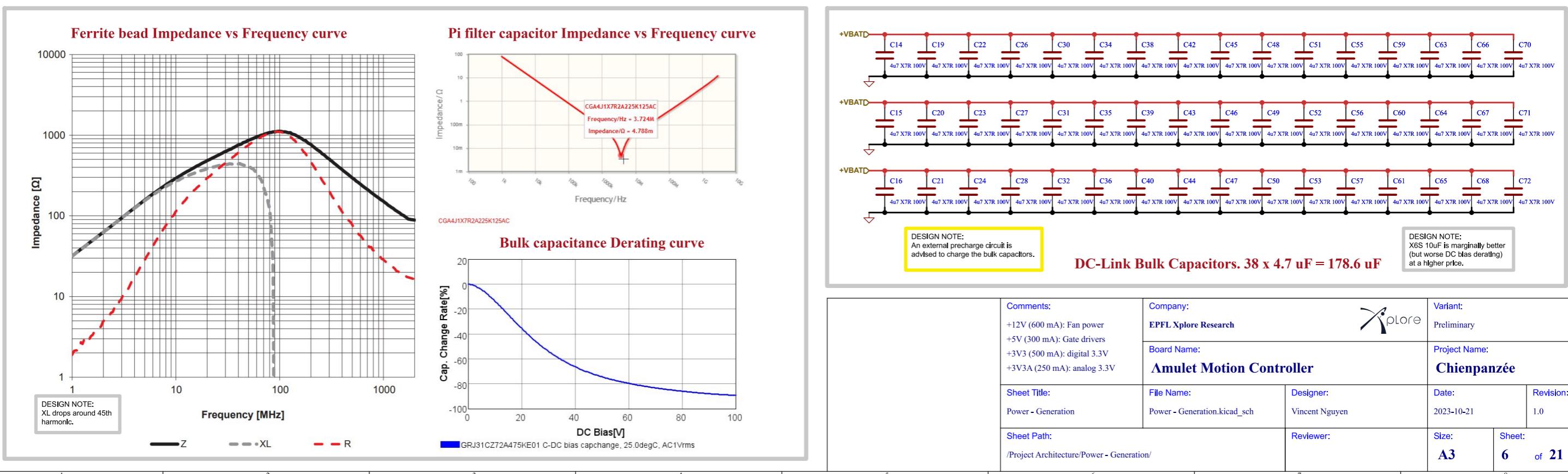
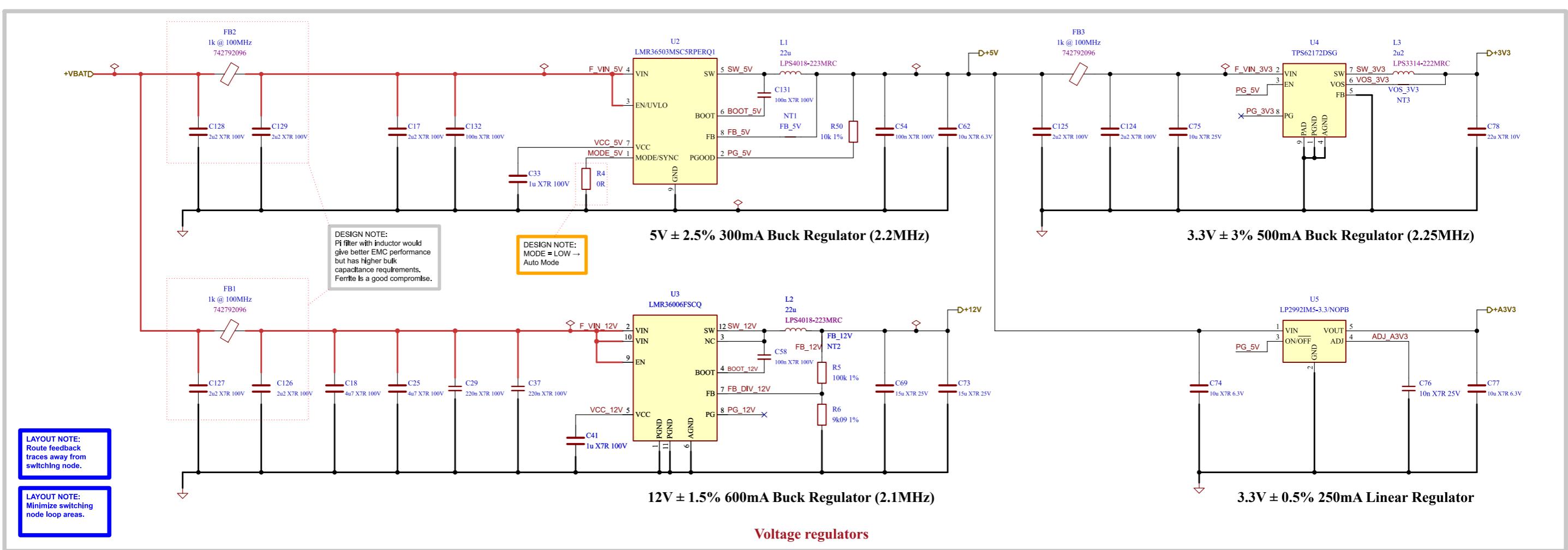


	Comments:	Company: EPFL Xplore Research	Variant: Preliminary
	<b>Board Name:</b> <b>Amulet Motion Controller</b>		
	Sheet Title: MCU - Power	File Name: MCU - Power.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/MCU - Power/	Reviewer:	Date: 2023-10-14      Revision: 1.0

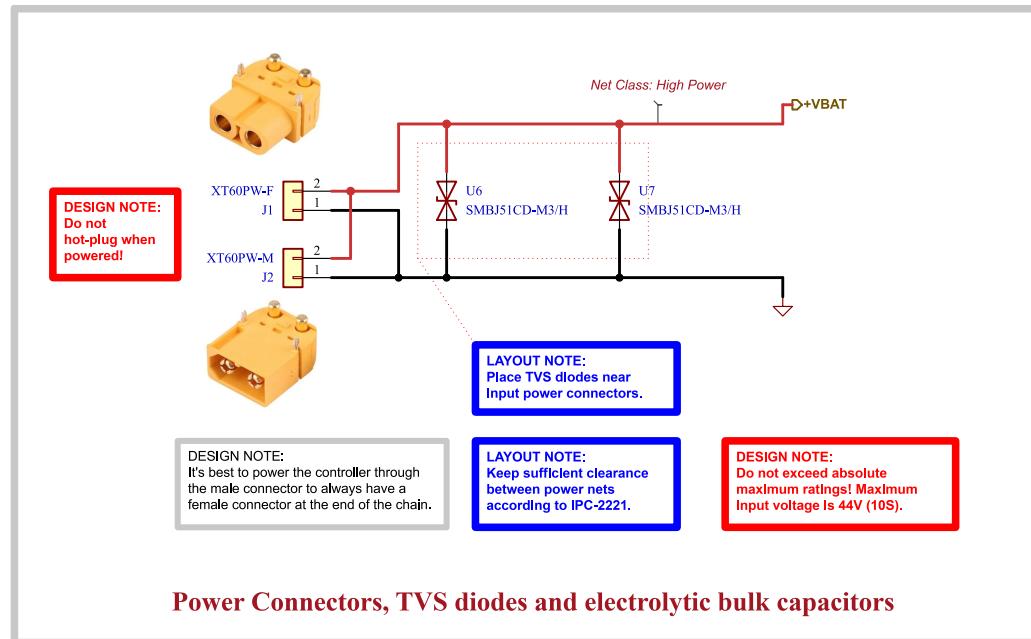
# [5] MCU - I/Os



# [6] Power - Generation

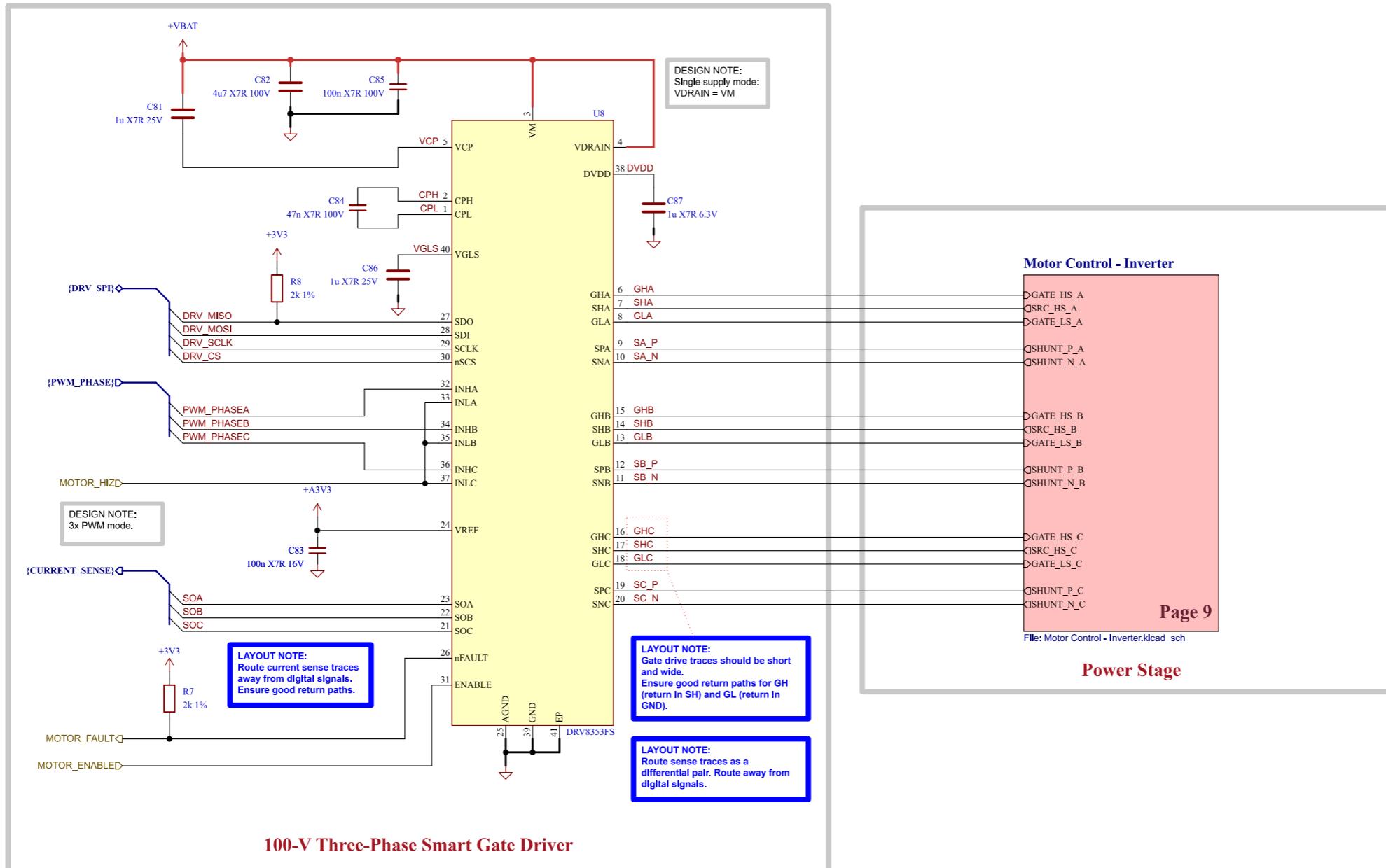


# [7] Power - Connectors



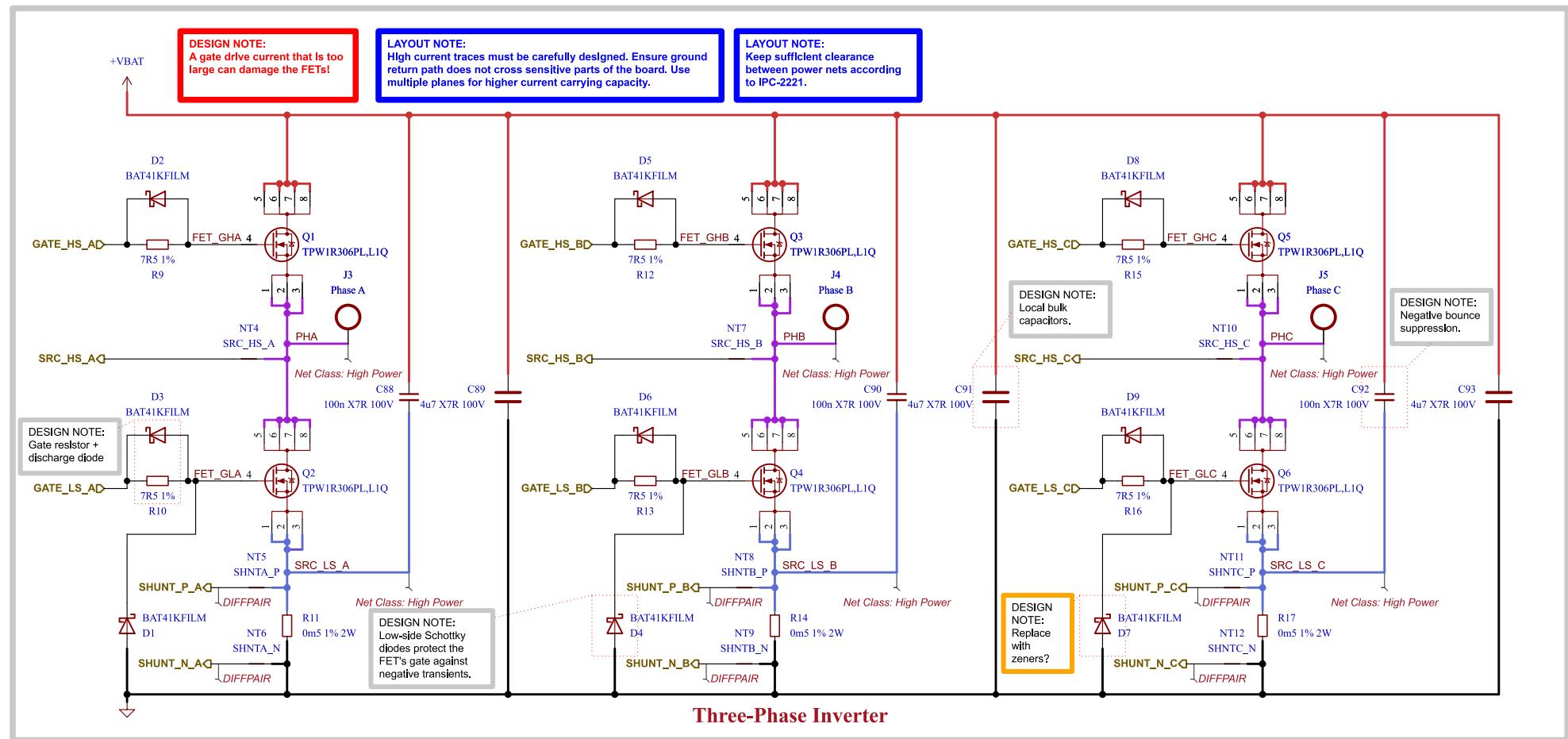
	Comments:   	Company: EPFL Xplore Research 	Variant: Preliminary
	Board Name: <b>Amulet Motion Controller</b>		Project Name: <b>Chienpanzée</b>
	Sheet Title: Power - Connectors	File Name: Power - Connectors.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/Power - Connectors/	Reviewer:	Date: 2023-10-14    Revision: 1.0

# [8] Motor Control - Top Level



Comments:	Company: EPFL Xplore Research	Variant: Preliminary
Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzée</b>	
Sheet Title: Motor Control - Top Level	File Name: Motor Control - Top Level.kicad_sch	Designer: Vincent Nguyen
Sheet Path: /Project Architecture/Motor Control - Top Level/	Reviewer:	Date: 2023-10-16 Revision: 1.0

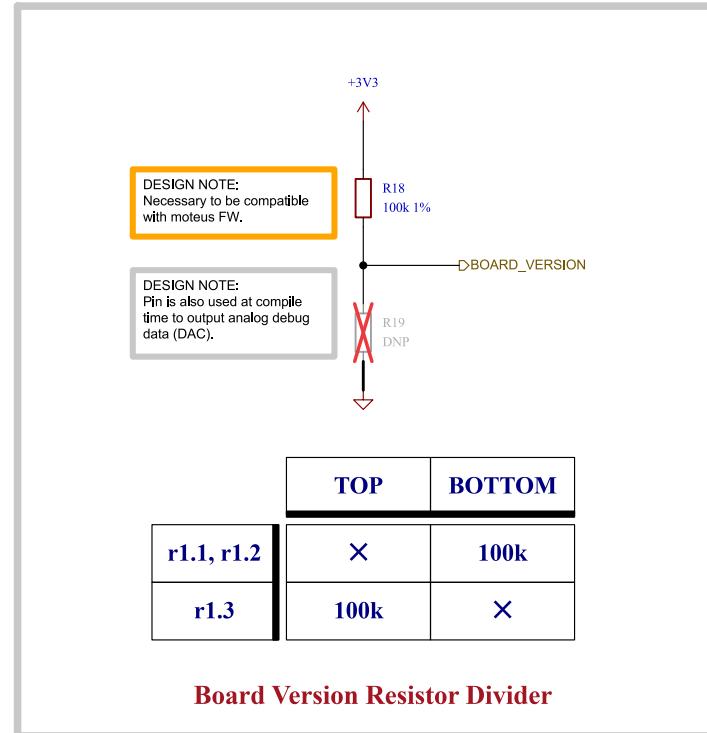
# [9] Motor Control - Inverter



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

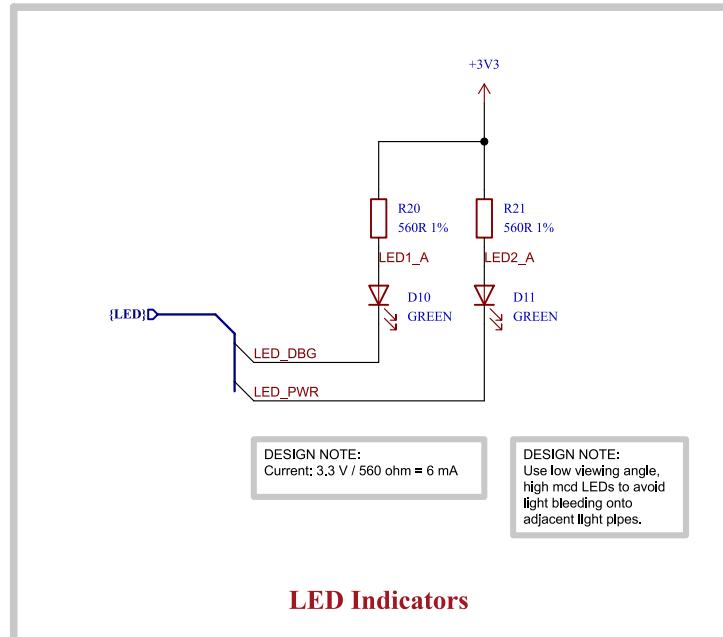
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Board Name: <b>Amulette Motion Controller</b>	Project Name: <b>Chienpanzée</b>	
Sheet Title: Motor Control - Inverter	File Name: Motor Control - Inverter.kicad_sch	Designer: Vincent Nguyen
Sheet Path: /Project Architecture/Motor Control - Top Level/Motor Control - Inverter/	Reviewer:	Date: 2023-10-18 Revision: 1.0

# [10] Misc - Board Version Divider, DAC



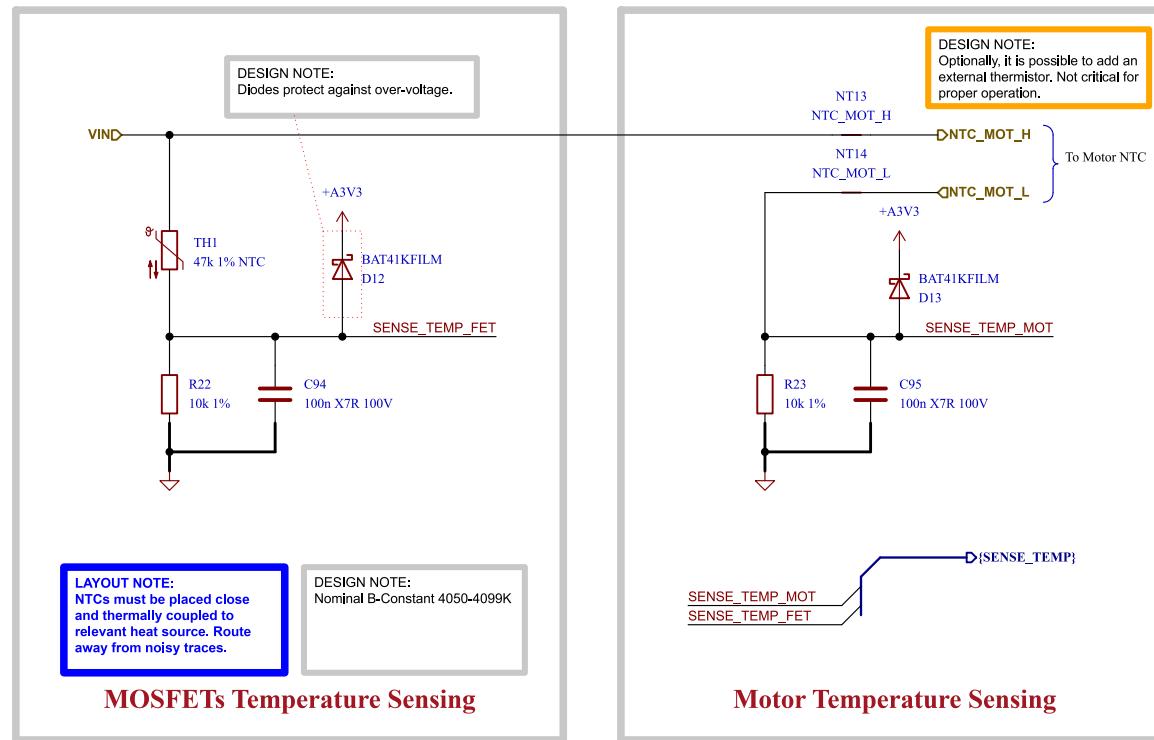
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	<b>Board Name:</b> <b>Amulet Motion Controller</b>		
	Sheet Title: Misc - Board Version Divider, DAC	File Name: Misc - Board Version Divider DAC.kicad_file	Designer: Adrian Nguyen
	Sheet Path: /Project Architecture/Misc - Board Version Divider, DAC/	Reviewer:	Date: 2023-10-14 Revision: 1.0

# [11] User - LED Indicators



	Comments:	Company: <b>EPFL Xplore Research</b>	Variant: <b>polore</b> Preliminary
	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: <b>User - LED Indicators</b>	File Name: <b>User - LED Indicators.kicad_sch</b>	Designer: <b>Vincent Nguyen</b>
	Sheet Path: <b>/Project Architecture/User - LED Indicators/</b>	Reviewer:	Date: <b>2023-10-15</b> Revision: <b>1.0</b>

## [12] Sensing - Temperature



	Comments:	Company: <b>EPFL Xplore Research</b>	 Variant: Preliminary
		Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzée</b>
	<b>Sheet Title:</b> Sensing - Temperature	<b>File Name:</b> Sensing - Temperature.kicad_sch	<b>Designer:</b> Vincent Nguyen
	<b>Date:</b> 2023-10-14	<b>Revision:</b> 1.0	D
	<b>Sheet Path:</b> /Project Architecture/Sensing - Temperature/	<b>Reviewer:</b>	<b>Size:</b> <b>A4</b> <b>Sheet:</b> <b>12</b> of <b>21</b>

# [13] Sensing - Battery

A

B

C

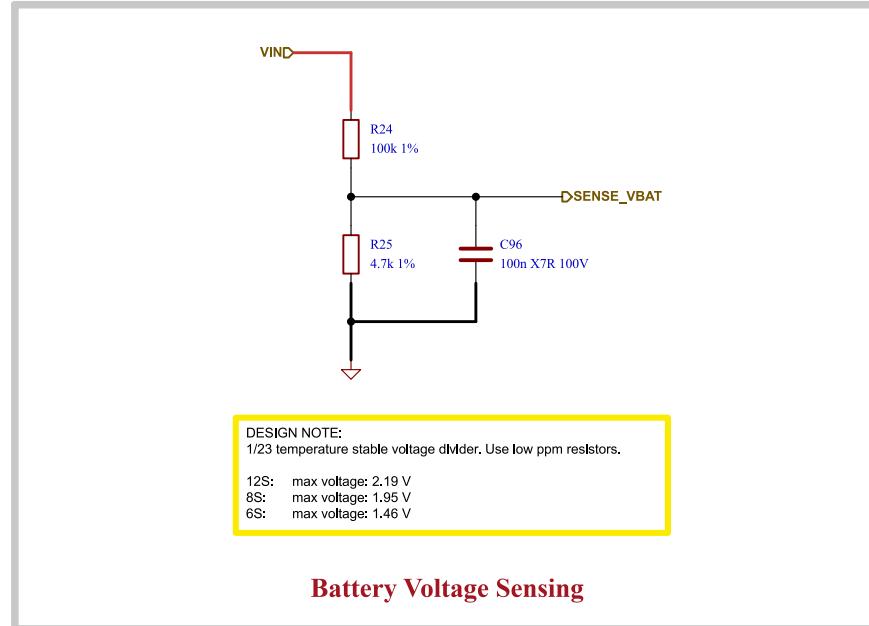
D

A

B

C

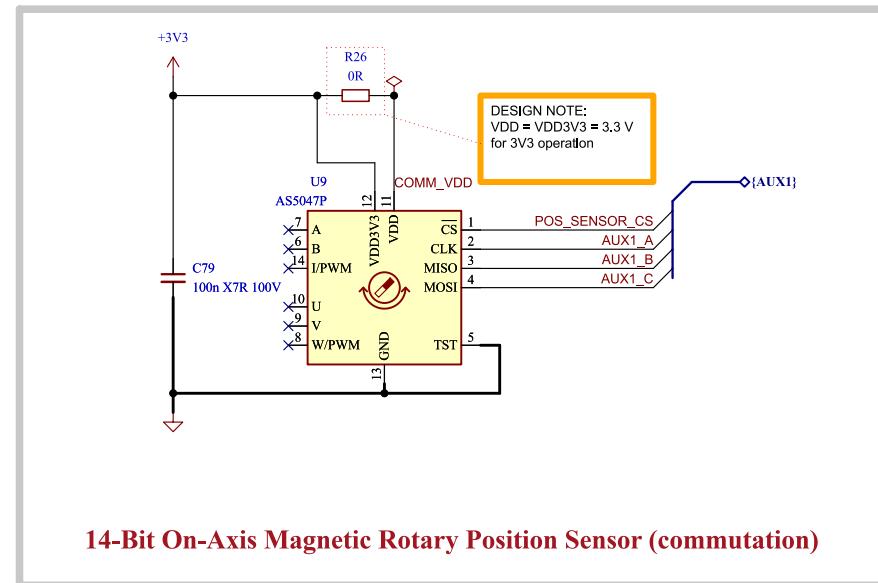
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	Comments:	Company: EPFL Xplore Research	Variant: Preliminary
	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: Sensing - Battery	File Name: Sensing - Battery.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/Sensing - Battery/	Reviewer:	Date: 2023-10-14 Revision: 1.0
		Size: <b>A4</b>	Sheet: <b>13</b> of <b>21</b>

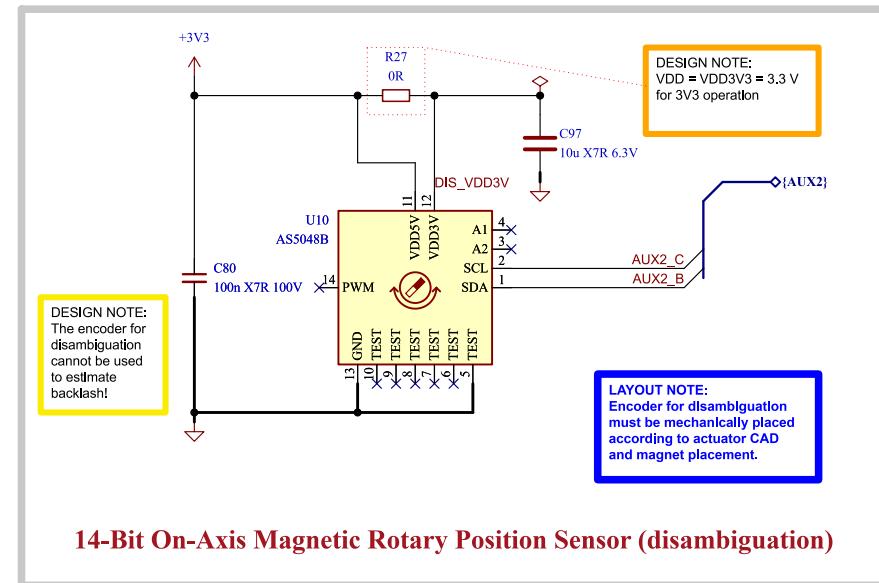
# [14] Sensing - Position

A



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

B



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

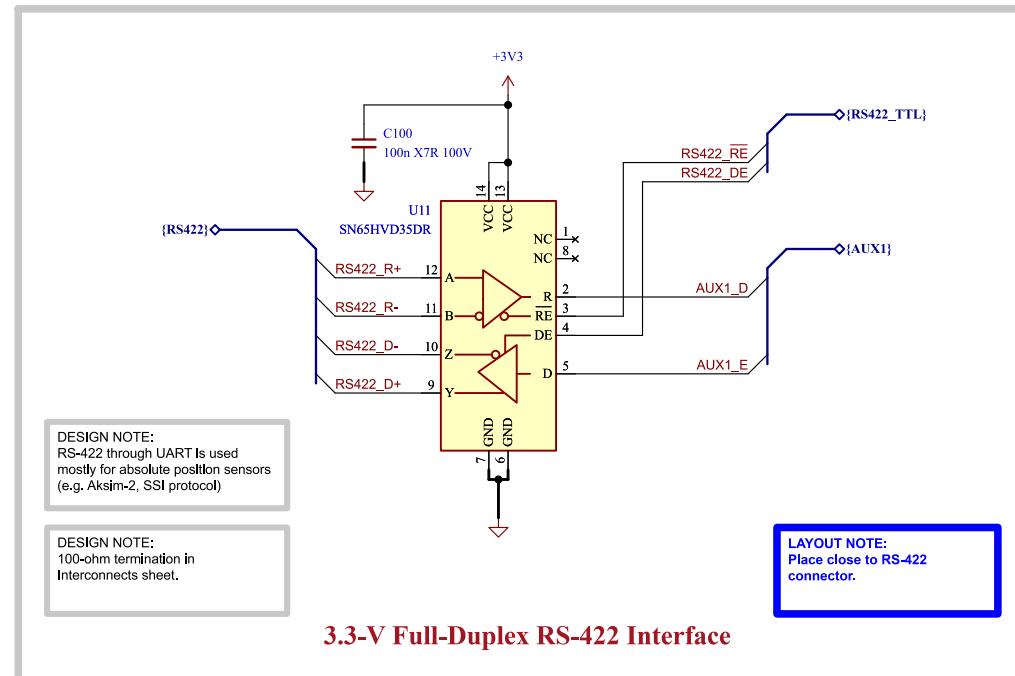
C

**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.

D

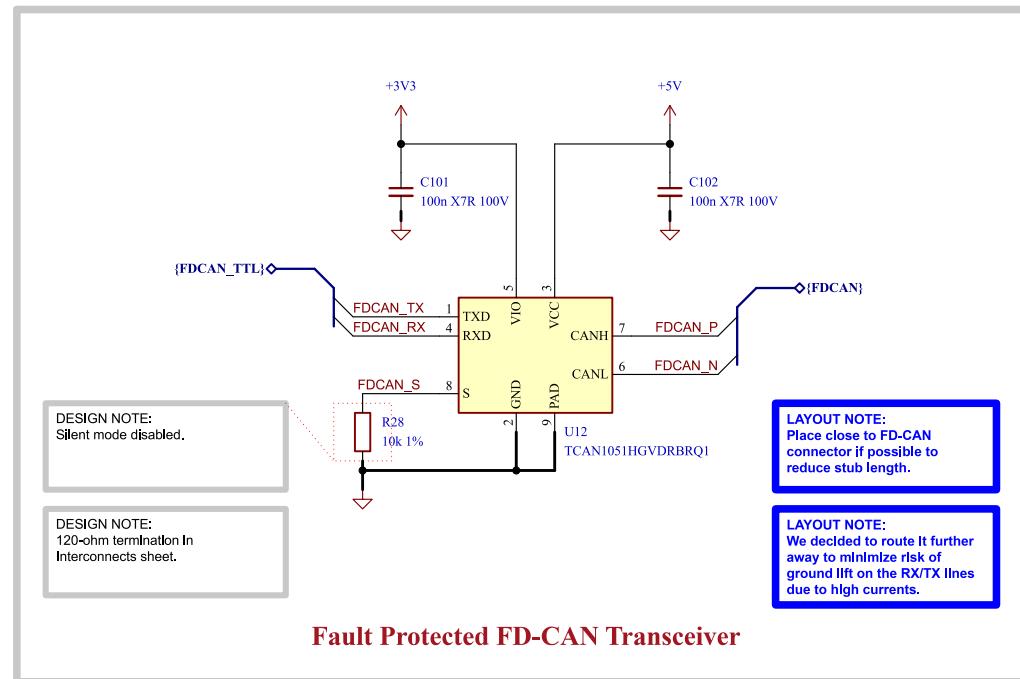
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	<b>Board Name:</b> <b>Amulet Motion Controller</b>		
	Sheet Title: Sensing - Position	File Name: Sensing - Position.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/Sensing - Position/	Reviewer:	Date: 2023-10-14    Revision: 1.0

# [15] Interface - RS-422



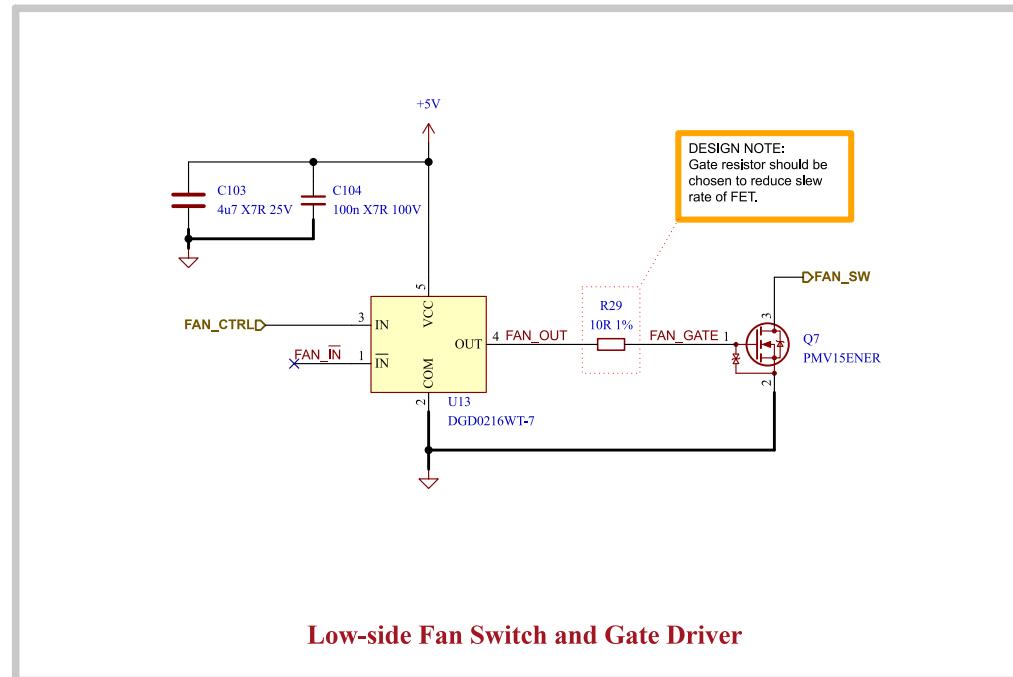
	Comments:	Company: EPFL Xplore Research	Variant: Preliminary
	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: Interface - RS-422	File Name: Interface - RS-422.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/Interface - RS-422/	Reviewer:	Date: 2023-10-15 Revision: 1.0

# [16] Interface - FD-CAN



	Comments:	Company: EPFL Xplore Research	Variant: Preliminary
	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: Interface - FD-CAN	File Name: Interface - FD-CAN.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/Interface - FD-CAN/	Reviewer:	Date: 2023-10-15 Revision: 1.0

# [17] Interface - Fan Control



A

B

C

D

A

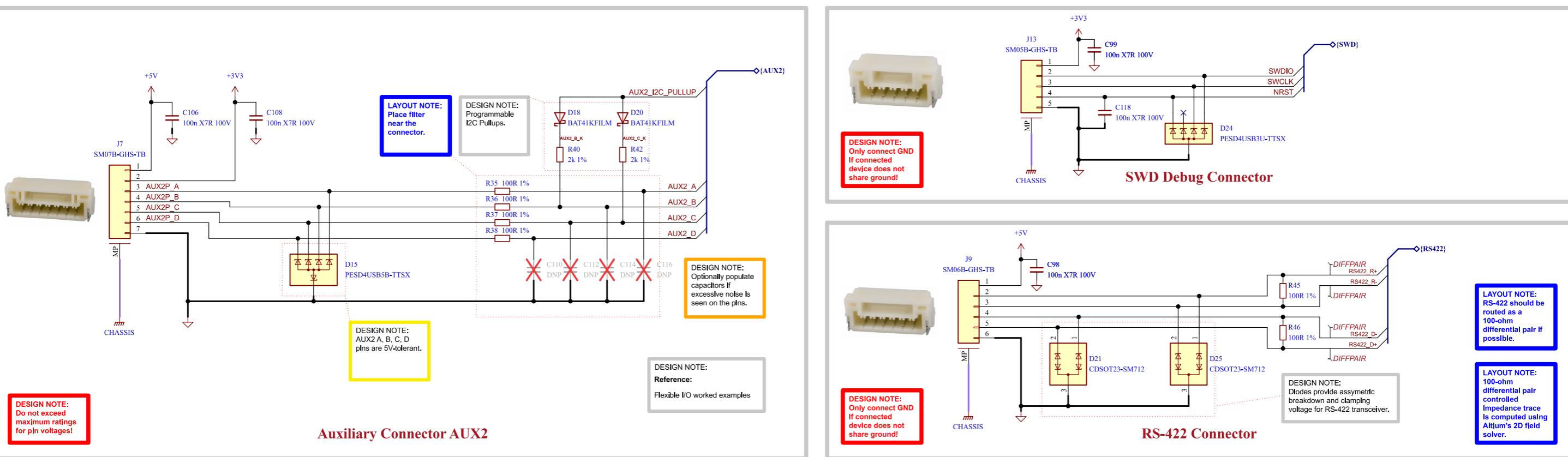
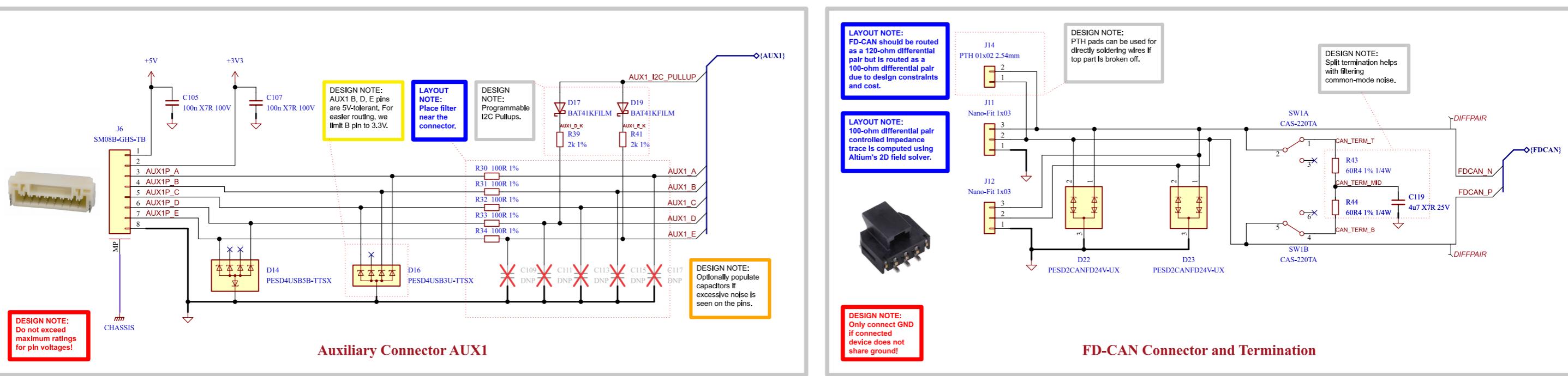
B

C

D

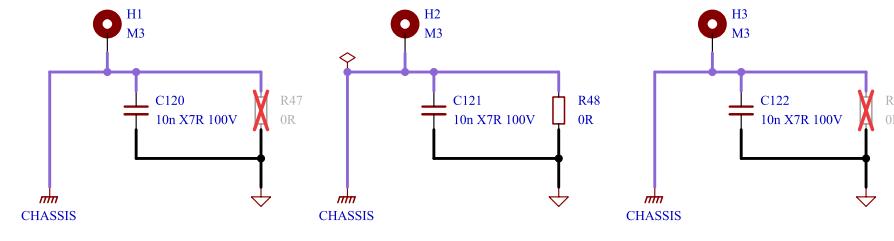
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	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: Interface - Fan Control	File Name: Interface - Fan Control.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: <a href="#">/Project Architecture/Interface - Fan Control/</a>	Reviewer:	Date: 2023-11-19 Revision: 1.0

# [18] Interface - Interconnects



Comments:	Company:	Variant:
	EPFL Xplore Research	 Preliminary
Sheet Title:	File Name:	Designer:
Interface - Interconnects	Interface - Interconnects.kicad_sch	Vincent Nguyen
Sheet Path:	Reviewer:	Date: 2023-10-14 Revision: 1.0
/Project Architecture/Interface - Interconnects/		
Size:	Sheet:	
A3	18	of 21

# [19] Mechanical - Holes



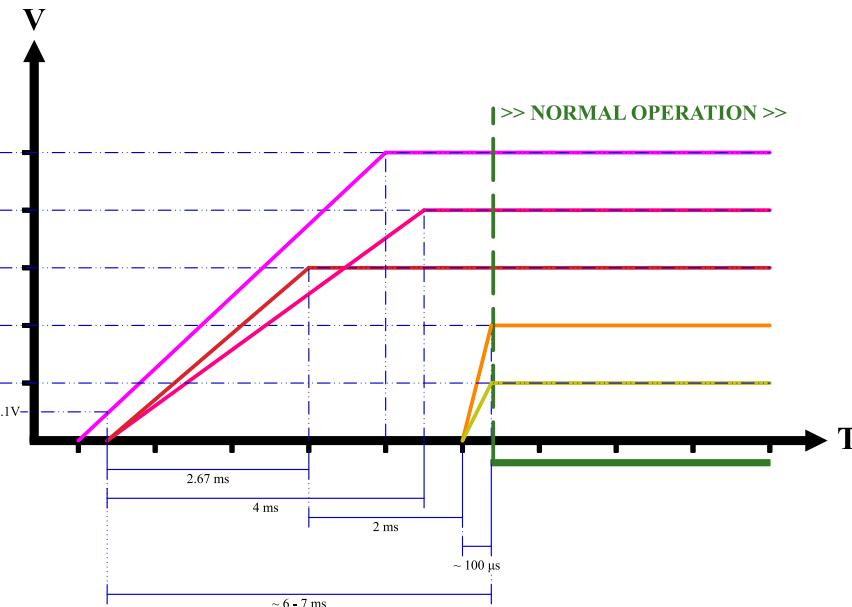
**DESIGN NOTE:**  
Optional RC filter for chassis  
grounding. Capacitors offer multi-point  
low-impedance connections at  
high-frequencies.

**Mounting Holes and Chassis Connection**

	Comments:	Company: EPFL Xplore Research	Variant: Preliminary
	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: Mechanical - Holes	File Name: Mechanical - Holes.kicad_sch	Designer: Vincent Nguyen
	Sheet Path: /Project Architecture/Mechanical - Holes/	Reviewer:	Date: 2023-10-22    Revision: 1.0

# [20] Power - Sequencing

NAME	SOURCE	LEVEL
+VBAT	BATTERY	12 - 44V
+12V	LMR36006	12V $\pm$ 1.5%
+5V	LMR36503	5V $\pm$ 1.5%
+3V3	TPS62172	3.3V $\pm$ 3%
+A3V3	LP2992	3.3V $\pm$ 0.5%



			Comments:	Company:	 EPFL Xplore Research	Variant:
			Board Name:	Preliminary		
			<b>Amulet Motion Controller</b>	Project Name:		<b>Chienpanzée</b>
			Sheet Title: Power - Sequencing	File Name: Power - Sequencing.kicad_sch	Designer: Vincent Nguyen	Date: 1.0
Sheet Path: <a href="#">/Power - Sequencing/</a>			Reviewer:	Size: <b>A4</b>	Sheet: <b>20</b> of <b>21</b>	

# [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

B - 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
- Changed buck regulators and added Pi filters
- Doubled bulk capacitance using 10uF X6S ceramics

C

D

1

	Comments:	Company: <b>EPFL Xplore Research</b> 	Variant: <b>Preliminary</b>
	Board Name: <b>Amulet Motion Controller</b>		
	Sheet Title: Revision History	File Name: Revision History.kicad_sch	Designer: Vincent Nguyen Date: 2023-10-15 Revision: 1.0
	Sheet Path: <a href="#">/Revision History/</a>	Reviewer:	Size: <b>A4</b> Sheet: <b>21 of 21</b>

2

3

4

5

6