

# Amulet Motion Controller

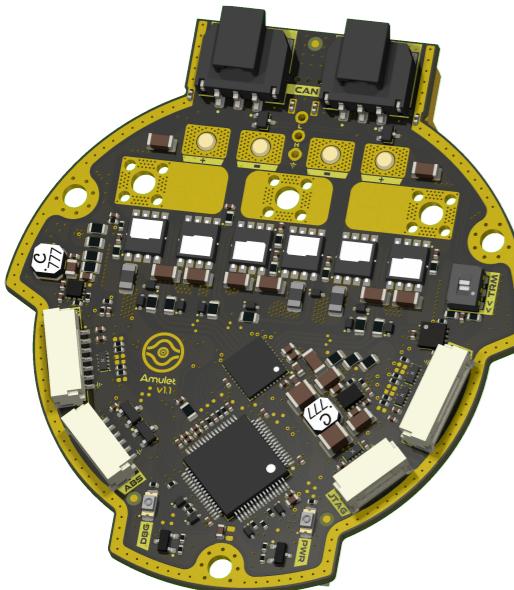
Variant: RELEASED

2024-11-24

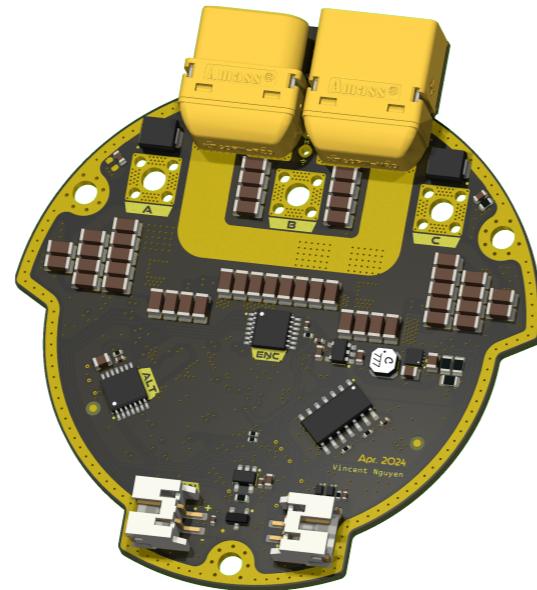
Rev 1.1

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## TOP VIEW



## BOTTOM VIEW



## 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.

## NOTES

Schematic based off Josh Pieper's moteus controllers.

Not fitted components are marked as

DRAFT - Very early stage of schematic, ignore details.

PRELIMINARY - Close to final schematic.

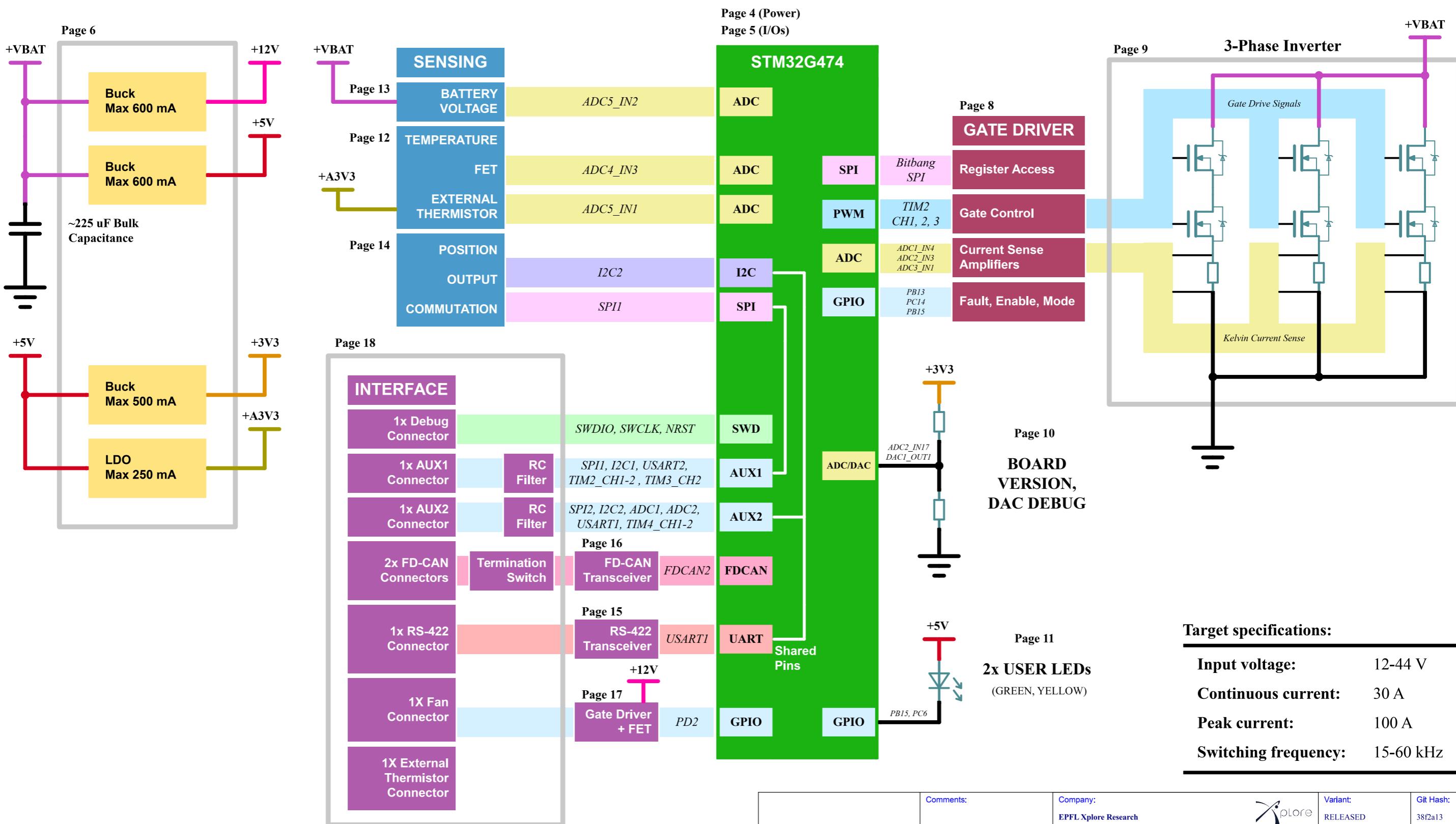
CHECKED - There shouldn't be any mistakes. Contact the engineer if you find any.

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

Date: 13-APR-2024

	Comments:	Company:	Exploré	
		EPFL Xplore Research	Variant: RELEASED	
	Board Name:	Amulet Motion Controller		Project Name: Chienpanzé
	Sheet Title:	File Name:	Designer:	Date: Revision:
	Cover Page	amulet_controller.kicad_sch	Vincent Nguyen	2024-04-13 1.1
	Sheet Path:	Reviewer:		Size: Sheet:
	/			A3 1 of 21

# [2] Block Diagram

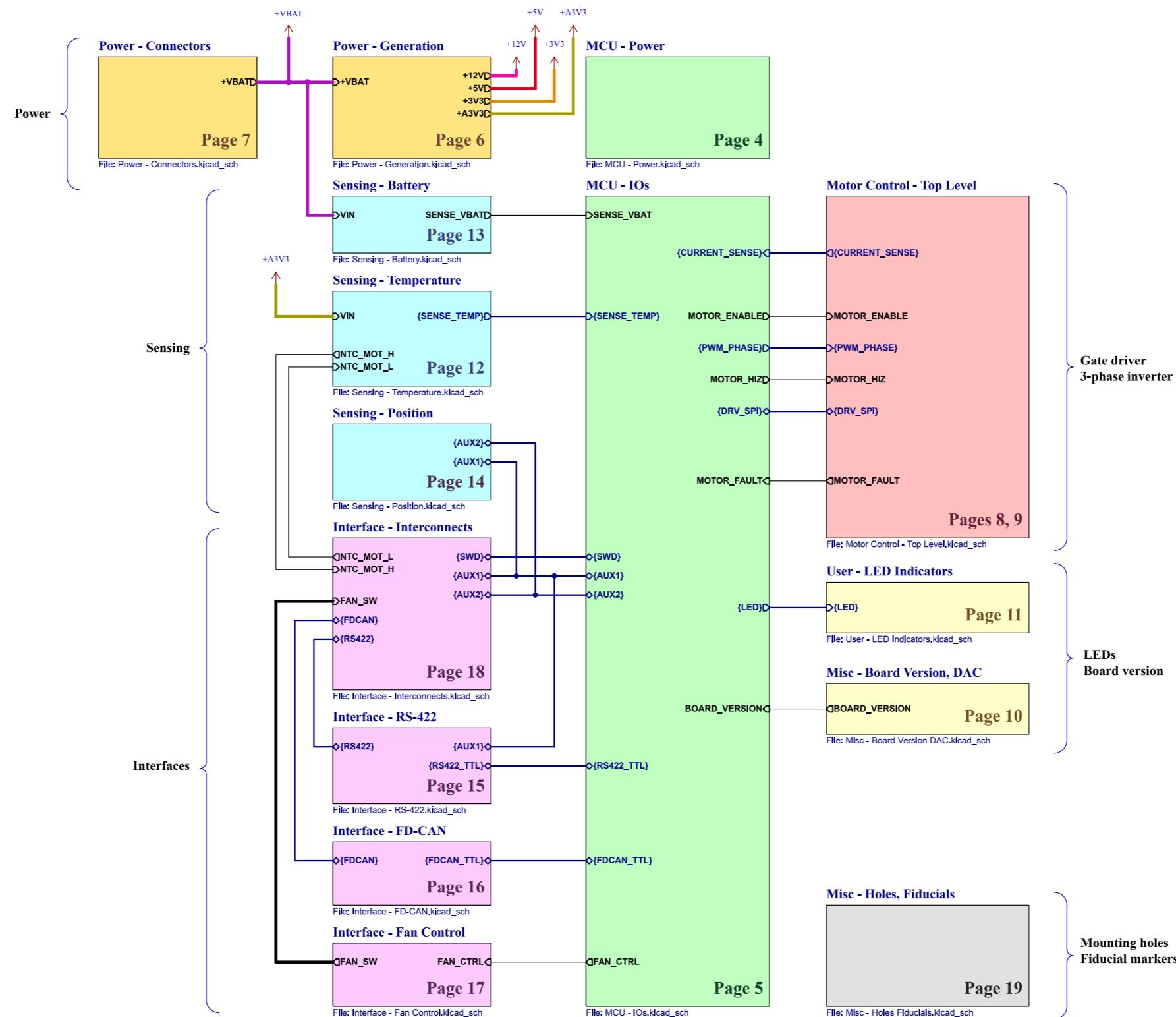


## Target specifications:

Input voltage:	12-44 V
Continuous current:	30 A
Peak current:	100 A
Switching frequency:	15-60 kHz

Comments:	Company: EPFL Xplore Research		Variant: RELEASED	Git Hash: 38f2a13
	Board Name: Amulet Motion Controller		Project Name: Chienpanzé	
Sheet Title: Block Diagram	File Name: Block Diagram.kicad_sch	Designer: Vincent Nguyen	Date: 2024-04-13	Revision: 1.1
Sheet Path: /Block Diagram/	Reviewer:		Size: A3	Sheet: 2 of 21

# [3] Project Architecture



	Comments:	Company: EPFL Xplore Research	Variant: RELEASED
	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>	
Sheet Title:	File Name: Project Architecture	Designer: Vincent Nguyen	Date: 2023-12-22
Sheet Path:	/Project Architecture/	Reviewer:	Revision: 1.1
	Size: <b>A3</b>	Sheet: <b>3 of 21</b>	

## [4] MCU - Power



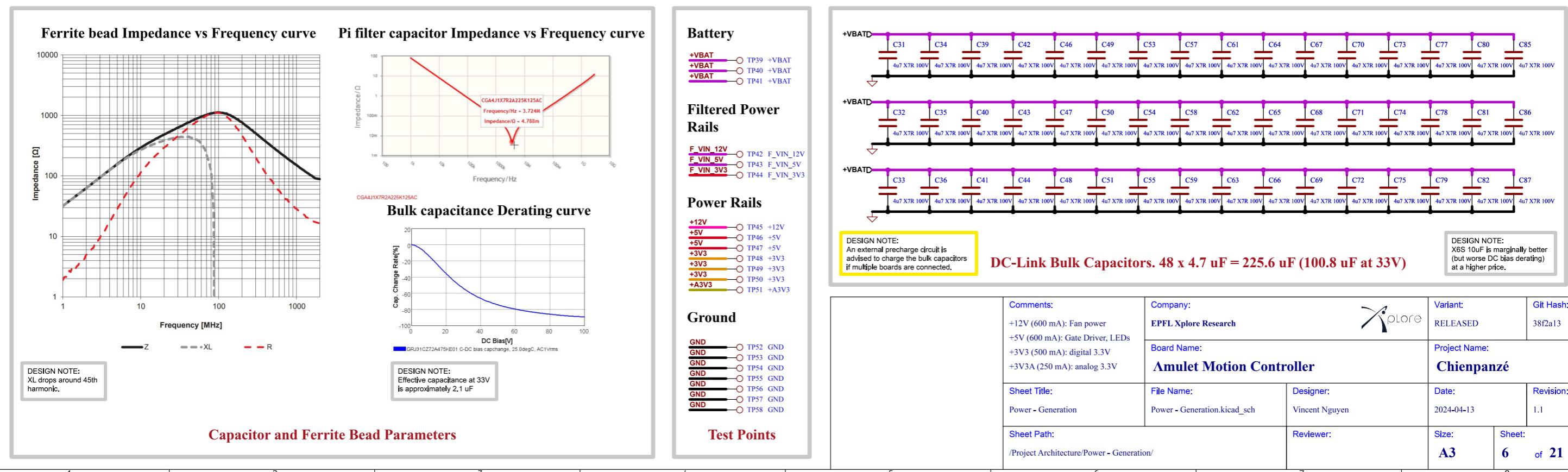
	Comments: AN5346 STM32G474 Datasheet p.81 J. Pieper ADC investigation	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	<b>Board Name:</b> <b>Amulet Motion Controller</b>			<b>Project Name:</b> <b>Chienpanzé</b>
	Sheet Title: MCU - Power	File Name: MCU - Power.kicad_sch	Designer: Vincent Nguyen	Date: 2023-12-18
	Sheet Path: /Project Architecture/MCU - Power/	Reviewer:	Size: <b>A4</b>	Sheet: <b>4</b> of <b>21</b>

# [5] MCU - I/Os

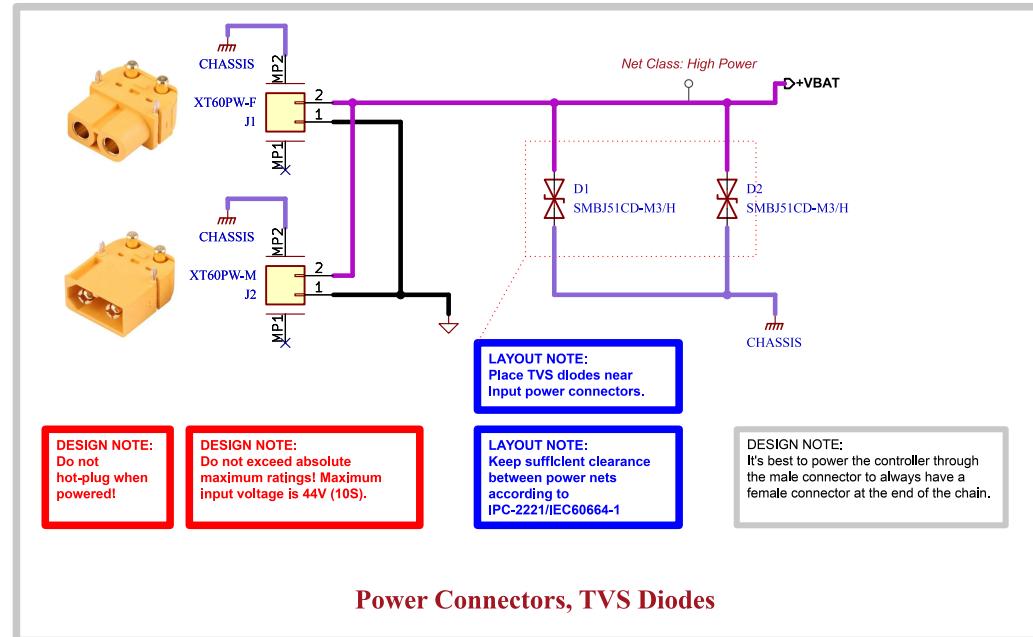


Comments: References: Flexible I/O worked examples Flexible I/O source configuration	Company: EPFL Xplore Research		Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>		
Sheet Title: MCU - I/Os	File Name: MCU - IOs.kicad_sch	Designer: Vincent Nguyen	Date: 2023-12-20	Revision: 1.1
Sheet Path: /Project Architecture/MCU - IOs/	Reviewer:	Size: <b>A3</b>	Sheet: <b>5</b> of <b>21</b>	

# [6] Power - Generation

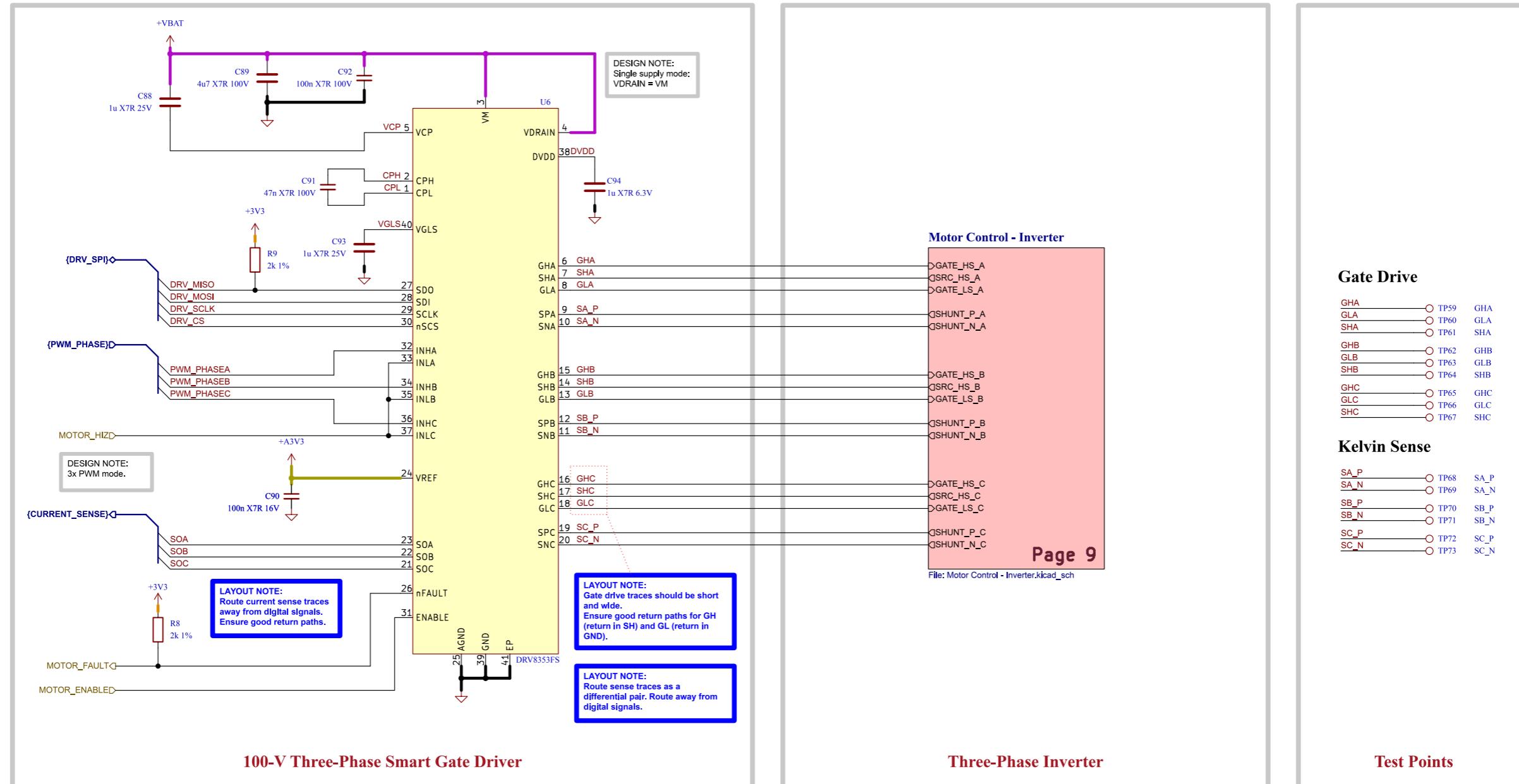


# [7] Power - Connectors



	Comments:   	Company: EPFL Xplore Research 	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>			Project Name: <b>Chienpanzé</b>
	Sheet Title: Power - Connectors	File Name: Power - Connectors.kicad_sch	Designer: Vincent Nguyen	Date: 2023-12-31
	Sheet Path: /Project Architecture/Power - Connectors/		Reviewer:  	Size: <b>A4</b> Sheet: <b>7</b> of <b>21</b>

# [8] Motor Control - Top Level



	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>		
	Sheet Title: Motor Control - Top Level	File Name: Motor Control - Top Level.kicad_sch	Designer: Vincent Nguyen	Date: 2023-12-20
	Sheet Path: /Project Architecture/Motor Control - Top Level/		Reviewer:	Revision: 1.1
			Size: <b>A3</b>	Sheet: <b>8</b> of <b>21</b>

# [9] Motor Control - Inverter



**LAYOUT NOTE:**  
High current traces must be carefully designed. Ensure ground return path does not cross sensitive parts of the board. Use multiple planes for higher current carrying capacity.

**LAYOUT NOTE:**  
Keep sufficient clearance between power nets according to IPC-2221/IEC60664-1.

**DESIGN NOTE:**  
A gate drive current that is too large can damage the FETs!

**Comments:**  
System Design Considerations for High-Power Motor Driver Applications  
Best Practices for Board Layout of Motor Drivers  
Proper RC Snubber Design for Motor Drivers

**Sheet Title:**  
Motor Control - Inverter

**Sheet Path:**  
/Project Architecture/Motor Control - Top Level/Motor Control - Inverter/

**Company:**  
EPFL Xplore Research

**Board Name:**  
**Amulet Motion Controller**

**File Name:**  
Motor Control - Inverter.kicad\_sch

**Designer:**  
Vincent Nguyen



**Variant:**  
RELEASED

**Git Hash:**  
38f2a13

**Project Name:**  
**Chienpanzé**

**Date:**  
2024-01-25

**Revision:**  
1.1

**Size:**  
**A4**

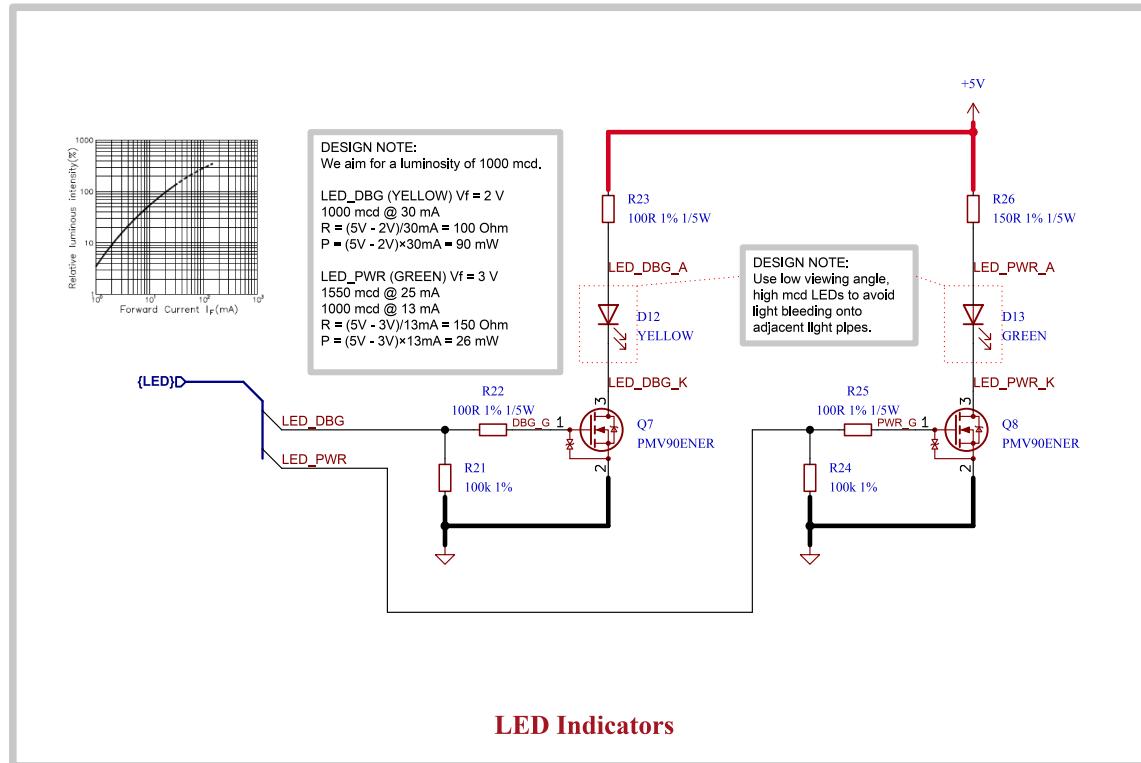
**Sheet:**  
**9** of **21**

# [10] Misc - Board Version, DAC



	Comments:	Company: EPFL Xplore Research		Variant:	Git Hash:
		Board Name: <b>Amulet Motion Controller</b>		Project Name: <b>Chienpanzé</b>	
	Sheet Title: Misc - Board Version, DAC	File Name: Misc - Board Version DAC.kicad_sch	Designer: Vincent Nguyen	Date: 2024-04-13	Revision: 1.1
	Sheet Path: <a href="#">/Project Architecture/Misc - Board Version, DAC/</a>	Reviewer:	Size: <b>A4</b>	Sheet: <b>10</b> of <b>21</b>	

# [11] User - LED Indicators



	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>		
	Sheet Title: User - LED Indicators	File Name: User - LED Indicators.kicad_sch	Designer: Vincent Nguyen	Date: 2023-12-19
	Sheet Path: <a href="#">/Project Architecture/User - LED Indicators/</a>		Reviewer:	Size: <b>A4</b> Sheet: <b>11</b> of <b>21</b>

# [12] Sensing - Temperature

A

B

C

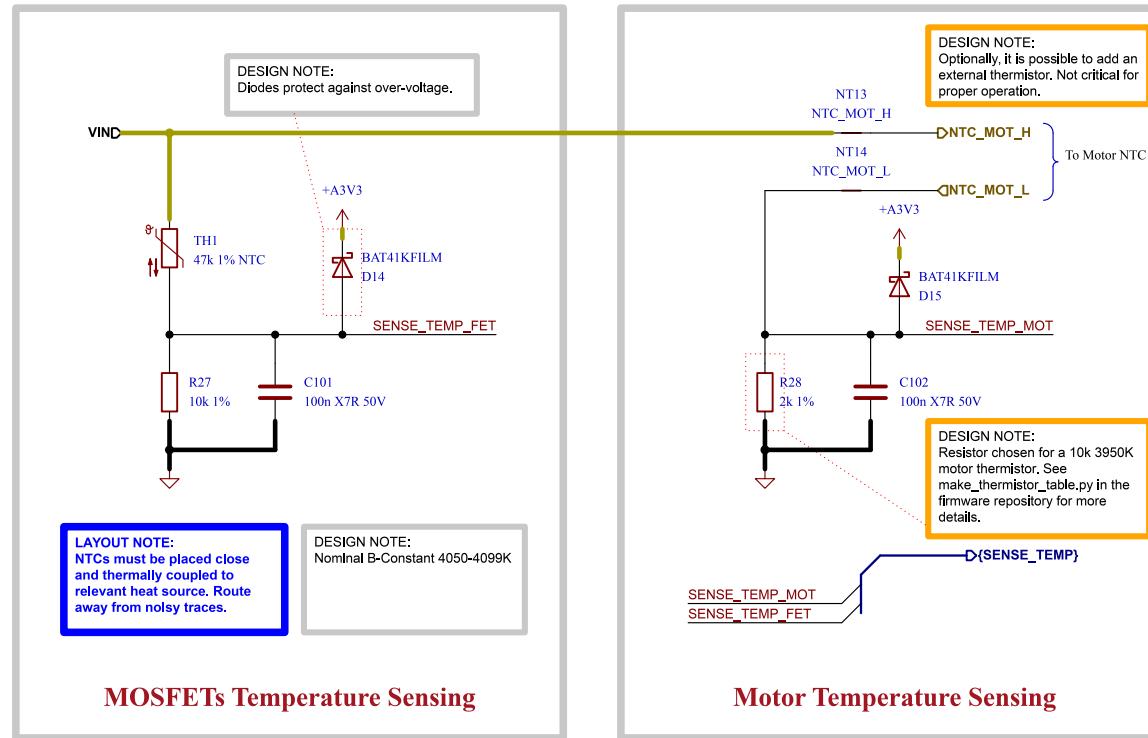
D

A

B

C

D



	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>		
	Sheet Title: Sensing - Temperature	File Name: Sensing - Temperature.kicad_sch	Designer: Vincent Nguyen	Date: 2024-04-13
	Sheet Path: /Project Architecture/Sensing - Temperature/		Reviewer:	Size: <b>A4</b> Sheet: <b>12</b> of <b>21</b>

# [13] Sensing - Battery

A

A

B

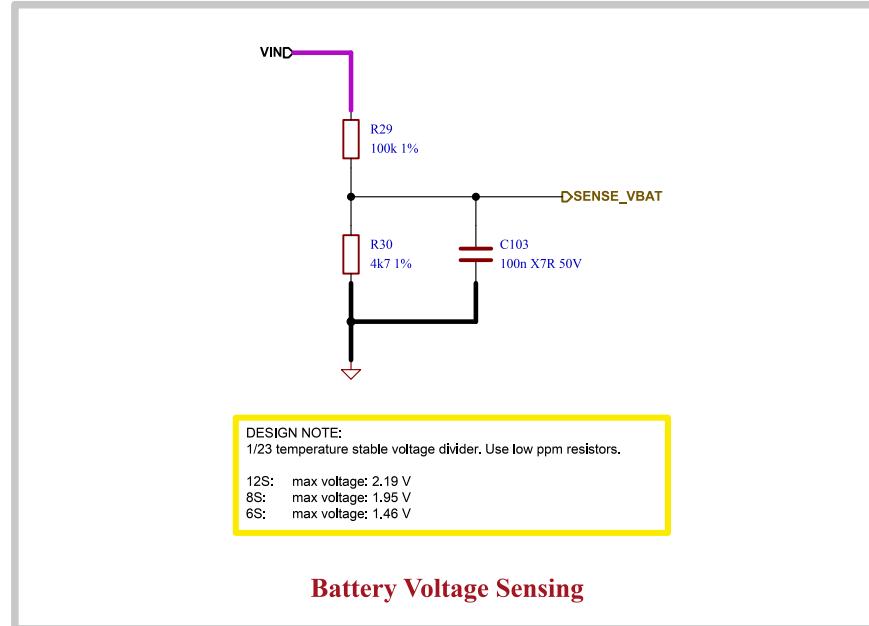
B

C

C

D

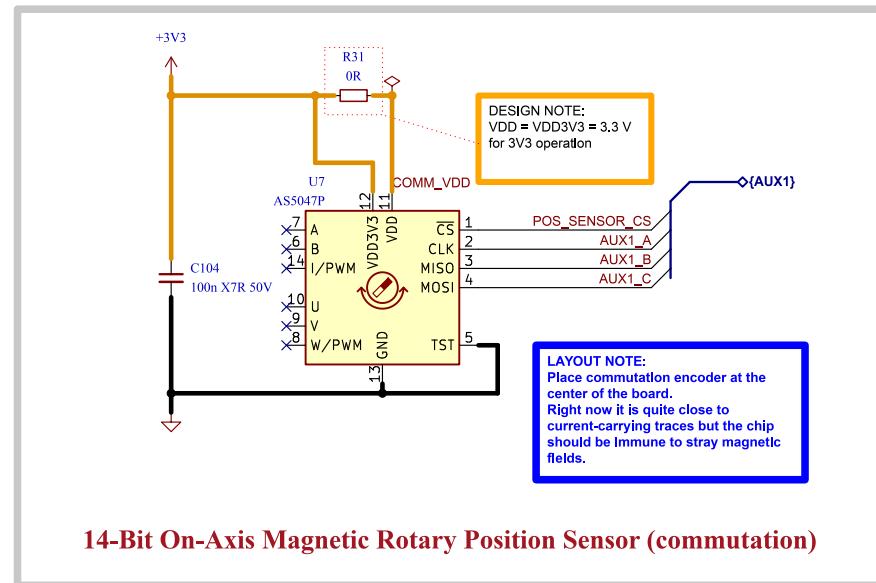
D



	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>			Project Name: <b>Chienpanzé</b>
	Sheet Title: Sensing - Battery	File Name: Sensing - Battery.kicad_sch	Designer: Vincent Nguyen	Date: 2023-10-14
	Sheet Path: /Project Architecture/Sensing - Battery/		Reviewer:	Size: <b>A4</b> Sheet: <b>13</b> of <b>21</b>

# [14] Sensing - Position

A



B



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

	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>			Project Name: <b>Chienpanzé</b>
	Sheet Title: Sensing - Position	File Name: Sensing - Position.kicad_sch	Designer: Vincent Nguyen	Date: 2023-10-14
	Sheet Path: /Project Architecture/Sensing - Position/		Reviewer:	Size: <b>A4</b> Sheet: <b>14</b> of <b>21</b>

# [15] Interface - RS-422



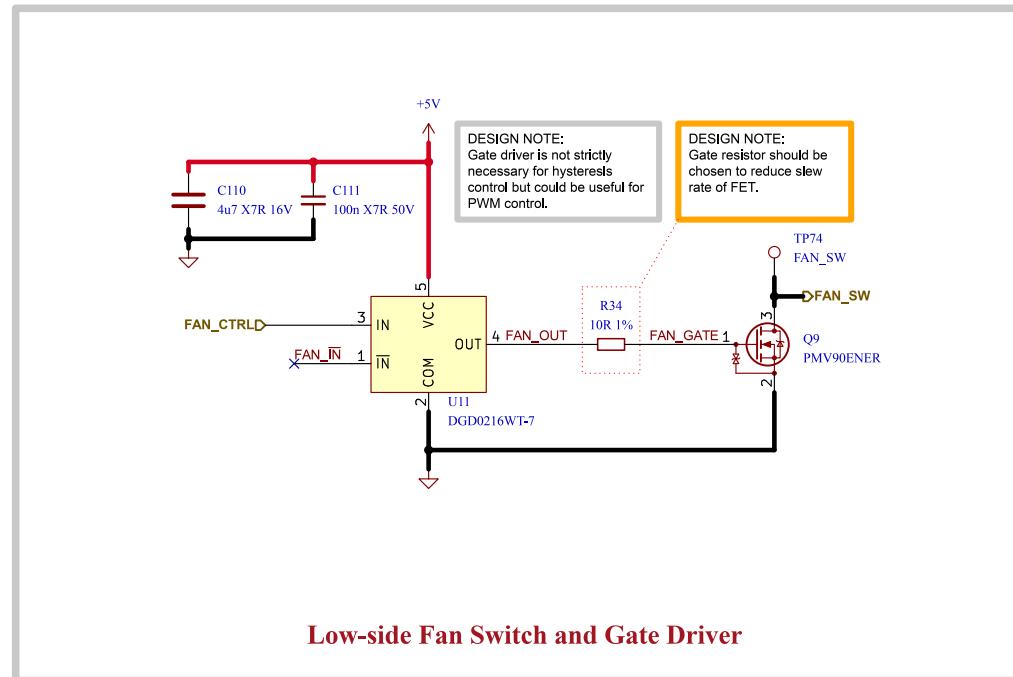
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	Board Name: <b>Amulette Motion Controller</b>			Project Name: <b>Chienpanzé</b>
	Sheet Title: Interface - RS-422	File Name: Interface - RS-422.kicad_sch	Designer: Vincent Nguyen	Date: 2023-10-15
	Sheet Path: /Project Architecture/Interface - RS-422/		Reviewer:	Size: <b>A4</b> Sheet: <b>15</b> of <b>21</b>

# [16] Interface - FD-CAN



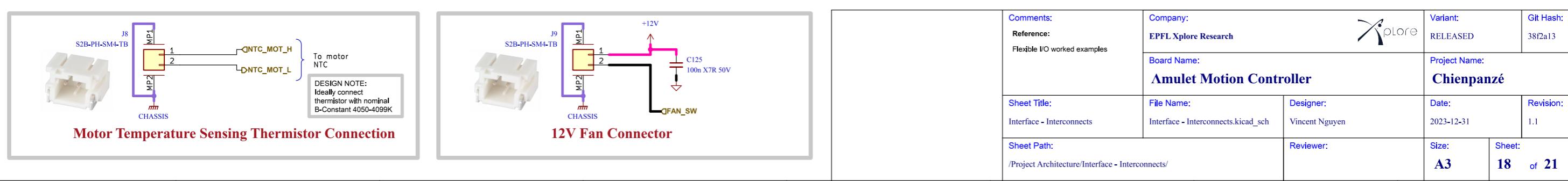
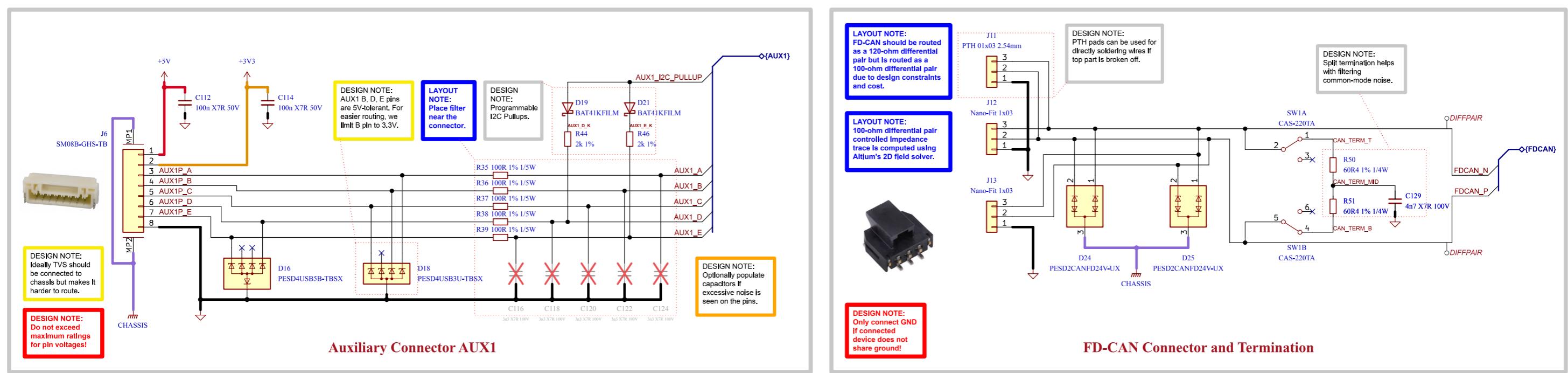
	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>			Project Name: <b>Chienpanzé</b>
	Sheet Title: Interface - FD-CAN	File Name: Interface - FD-CAN.kicad_sch	Designer: Vincent Nguyen	Date: 2023-10-15
	Sheet Path: /Project Architecture/Interface - FD-CAN/		Reviewer:	Size: <b>A4</b> Sheet: <b>16</b> of <b>21</b>

# [17] Interface - Fan Control



	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>		
	Sheet Title: Interface - Fan Control	File Name: Interface - Fan Control.kicad_sch	Designer: Vincent Nguyen	Date: 2023-11-19
	Sheet Path: <a href="#">/Project Architecture/Interface - Fan Control/</a>		Reviewer:	Size: <b>A4</b> Sheet: <b>17</b> of <b>21</b>

# [18] Interface - Interconnects



# [19] Misc - Holes, Fiducials

A

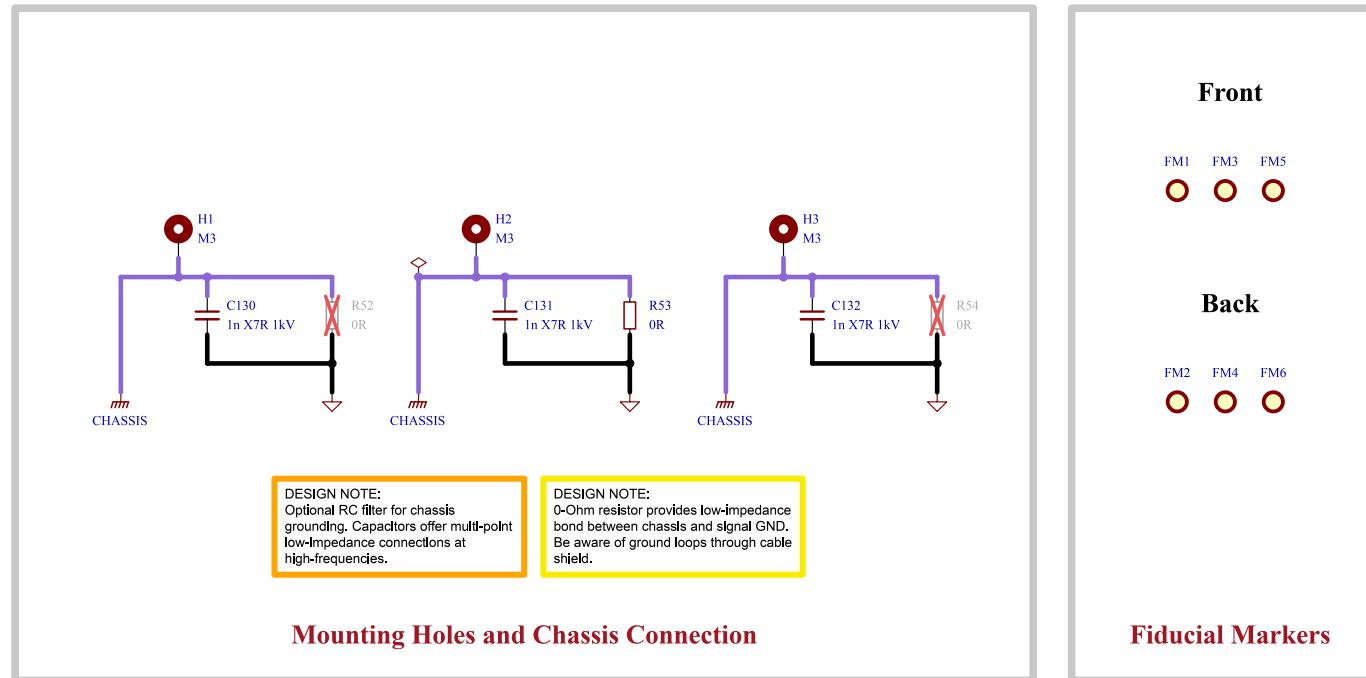
A

B

B

C

C



D

D

		Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
		Board Name: <b>Amulet Motion Controller</b>	Project Name: <b>Chienpanzé</b>		
		Sheet Title: Misc - Holes, Fiducials	File Name: Misc - Holes Fiducials.kicad_sch	Designer: Vincent Nguyen	Date: 2023-10-22
		Sheet Path: /Project Architecture/Misc - Holes, Fiducials/		Reviewer:	Size: <b>A4</b> Sheet: <b>19</b> of <b>21</b>

# [20] Power - Sequencing

A



B

C

D

	Comments:	Company: EPFL Xplore Research	Variant: RELEASED	Git Hash: 38f2a13
	Board Name: <b>Amulet Motion Controller</b>			Project Name: <b>Chienpanzé</b>
	Sheet Title: Power - Sequencing	File Name: Power - Sequencing.kicad_sch	Designer: Vincent Nguyen	Date: 2024-03-12
	Sheet Path: <a href="#">/Power - Sequencing/</a>			Revision: 1.1
	Reviewer:		Size: <b>A4</b>	Sheet: <b>20</b> of <b>21</b>

# [21] Revision History

	Comments:	Company: <b>EPFL Xplore Research</b>	 xplore	Variant: RELEASED	Git Hash: 38f2a13
		Board Name: <b>Amulet Motion Controller</b>		Project Name: <b>Chienpanzé</b>	
	<b>Sheet Title:</b> Revision History	<b>File Name:</b> Revision History.kicad_sch	<b>Designer:</b> Vincent Nguyen	<b>Date:</b> 2024-01-03	<b>Revision:</b> 1.1
	<b>Sheet Path:</b> /Revision History/		<b>Reviewer:</b>	<b>Size:</b> <b>A4</b>	<b>Sheet:</b> <b>21</b> of <b>21</b>