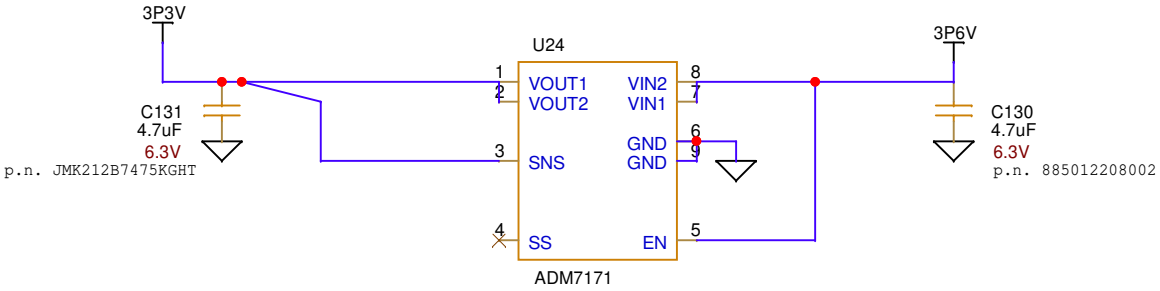
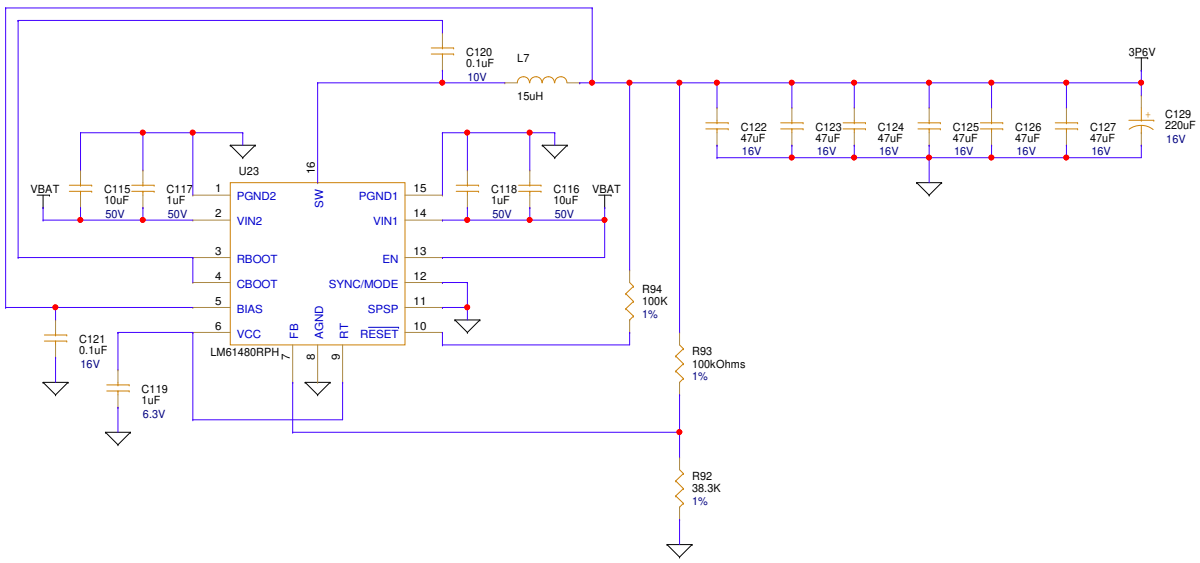


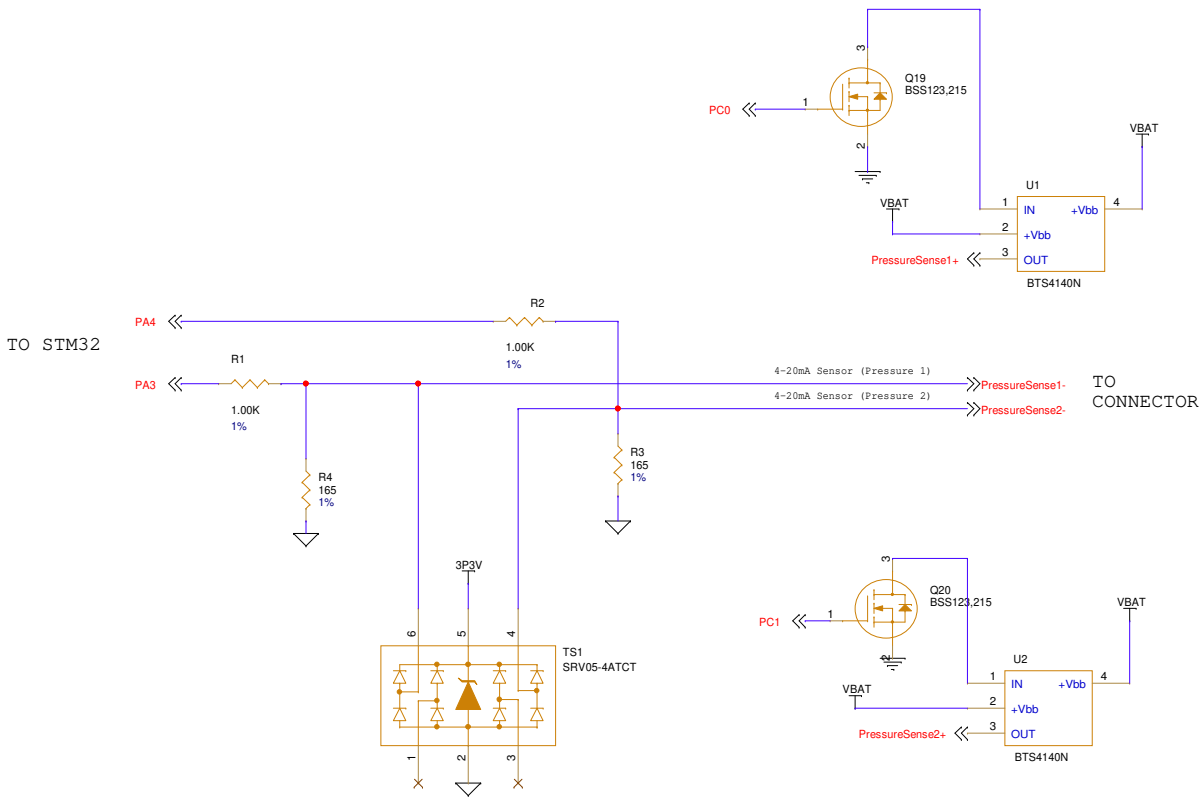
Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: 3P3V Linear Regulator			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 1 of 35

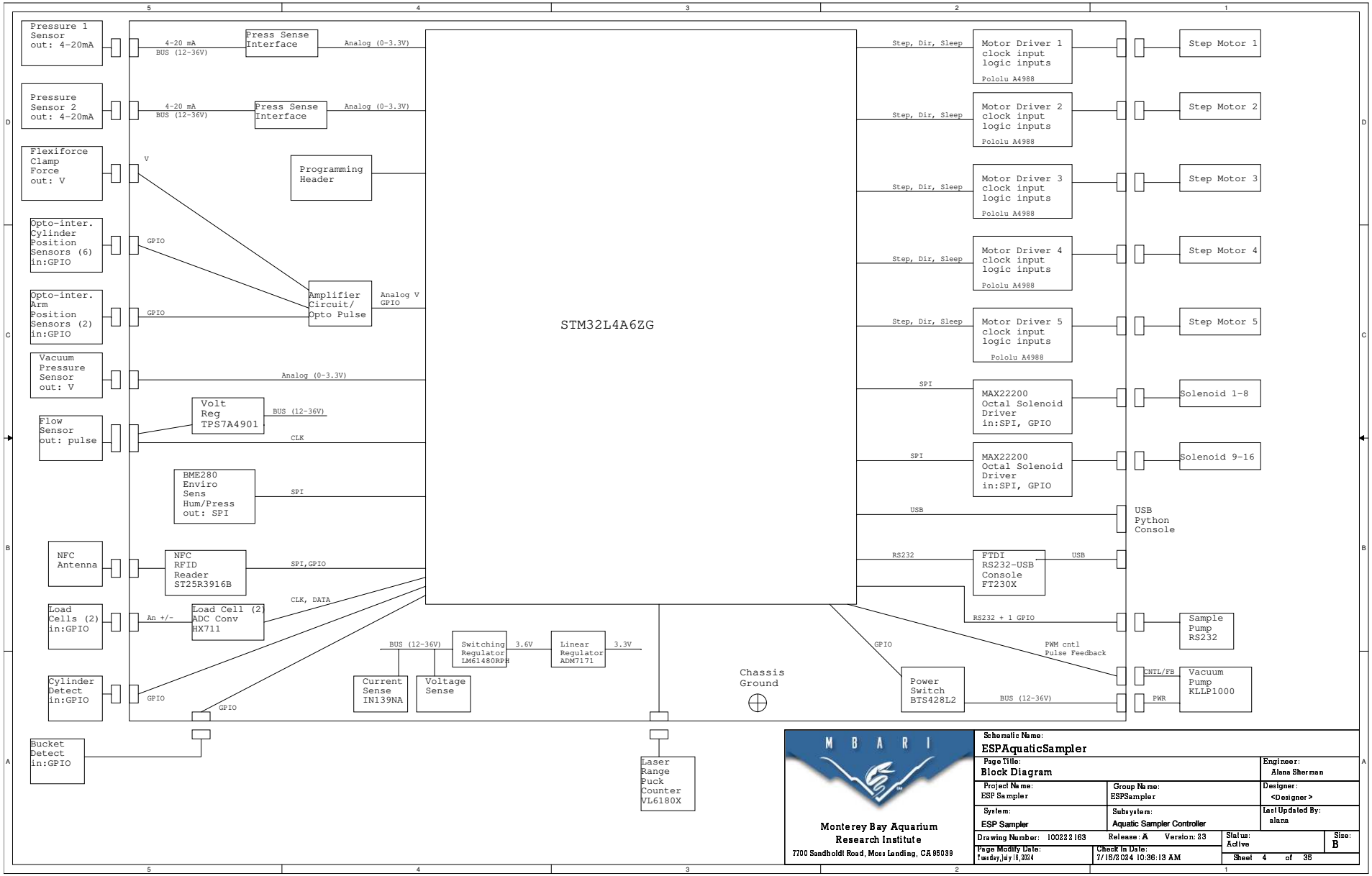


Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: 3P6V Converter			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 2 of 35

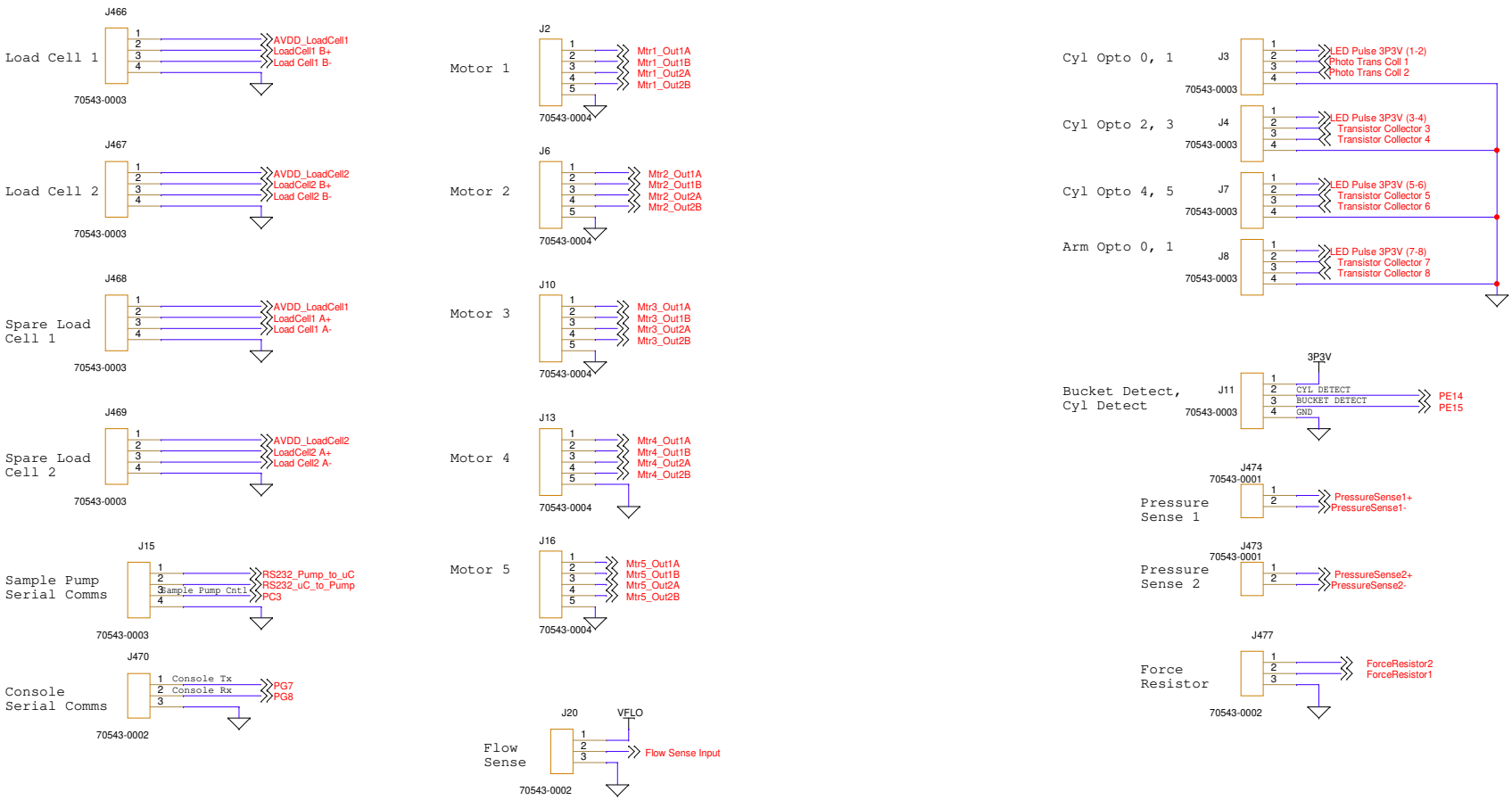


Monterey Bay Aquarium Research Institute 7700 Sandholdt Road, Moss Landing, CA 95039	Schematic Name: ESPAquaticSampler		
	Page Title: 4-20mA Pressure Sens Interface		Engineer: Alana Sherman
	Project Name: ESP Sampler	Group Name: ESPSampler	Designer: <Designer>
	System: ESP Sampler	Subsystem: Aquatic Sampler Controller	Last Updated By: alana
	Drawing Number: 100222163 Release: A Version: 23		Status: Active / Size: B
	Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM	Sheet 3 of 35



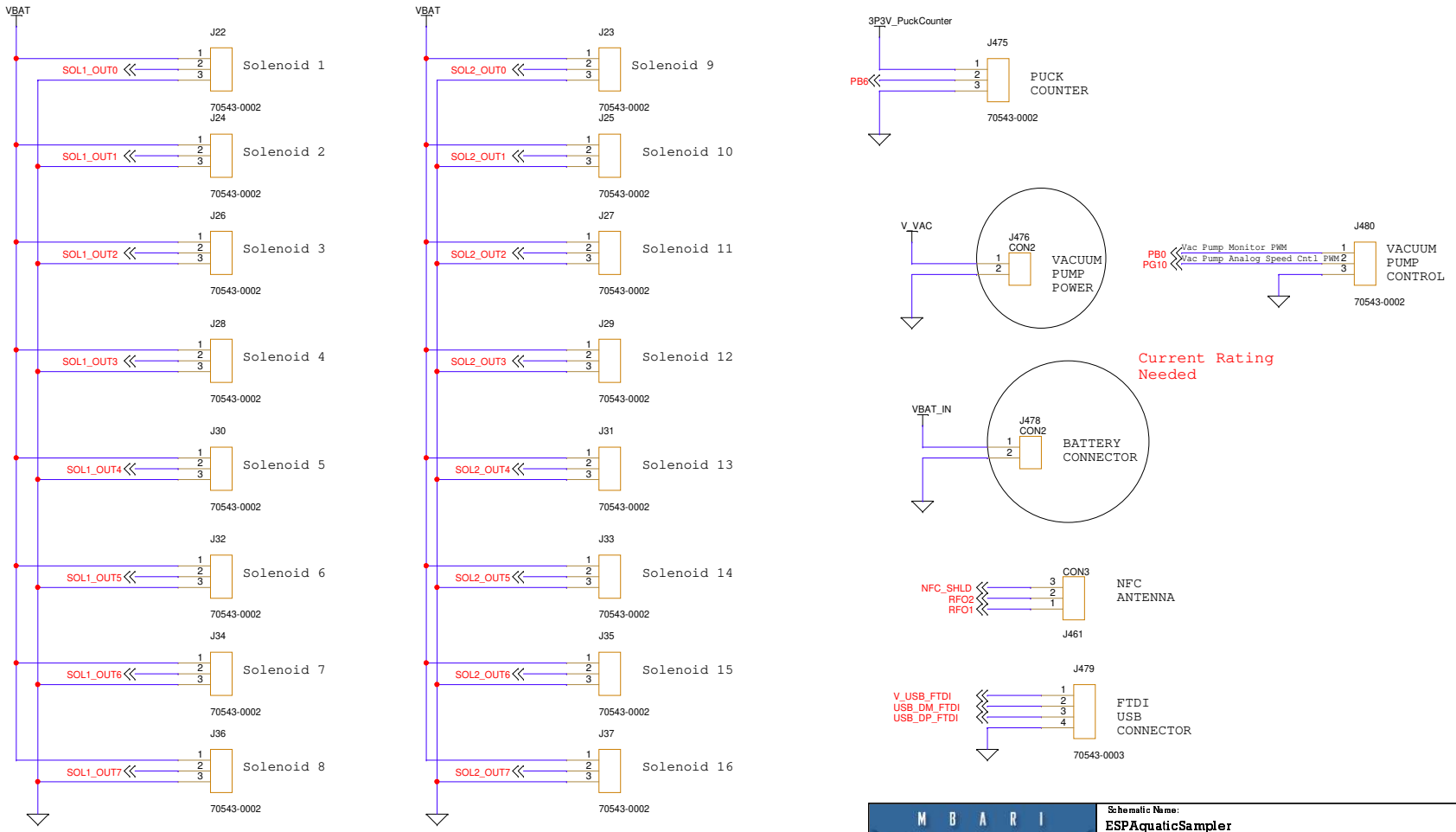
Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: Block Diagram			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/16/2024 10:36:13 AM		Sheet 4 of 35



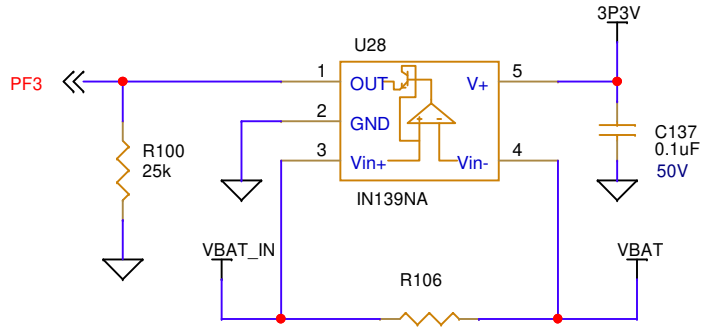
Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: Connectors 1			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/16/2024 10:36:13 AM		Sheet 5 of 35



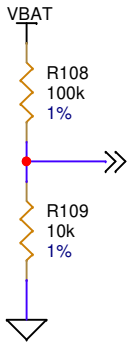
Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: Connectors 2			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 6 of 35




```
Vs~100 mV, for max 10A->
Vs=10A*Rs -> 100 mV/10A = 10mOhms

Vout = (Is)*(Rs)*(1mA/V)*Rl
for Rl=25K
Vout @10A = 2.5 V (max output)
Vout@1A = 0.25 V
```




```
For Vbus= 36V, Vout = 3.27V
For Vbus=12V V out= 1.09V
```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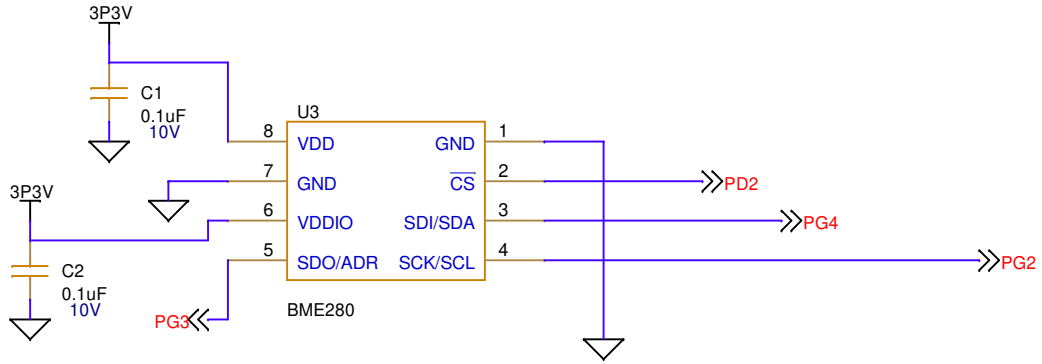
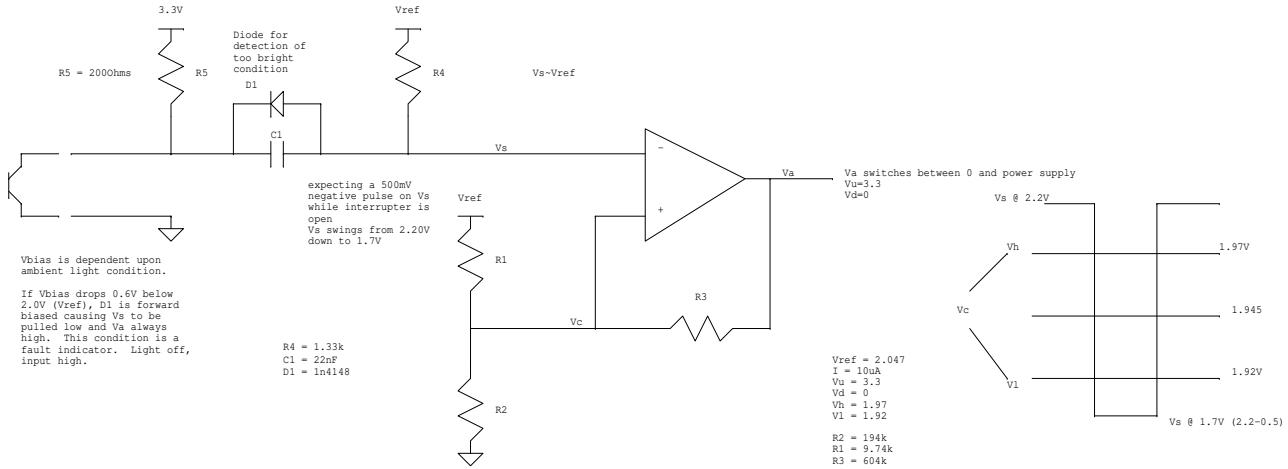
Schematic Name: ESPAquaticSampler			
Page Title: Current_Volt_Monitor			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 7 of 35



Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler		
Page Title: Enviromental Sensor BME280		Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler	Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller	Last Updated By: alana
Drawing Number: 100222163 Release: A Version: 23		Status: Active / Size: A
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM	Sheet 8 of 35



Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: ExplanationOfOptoInterrupters			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
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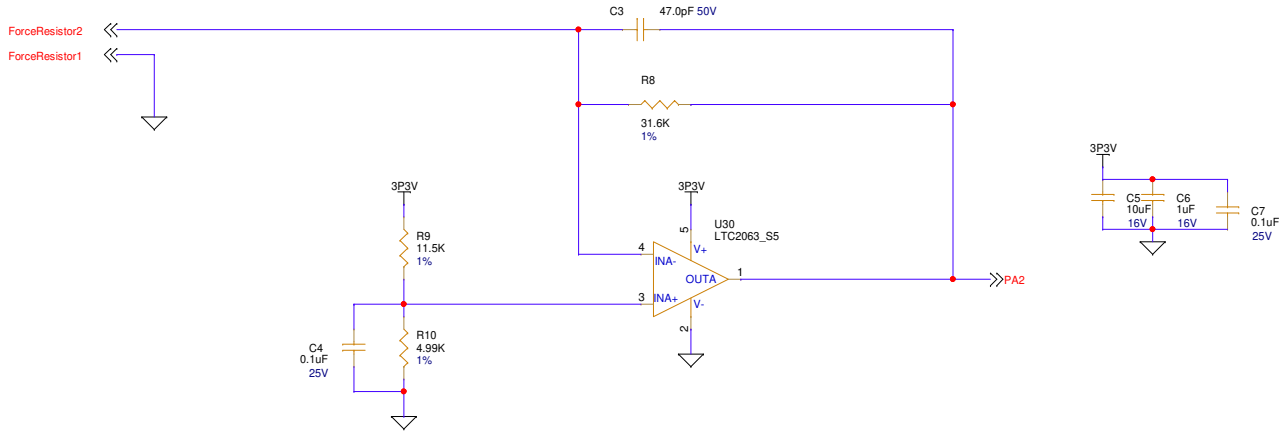
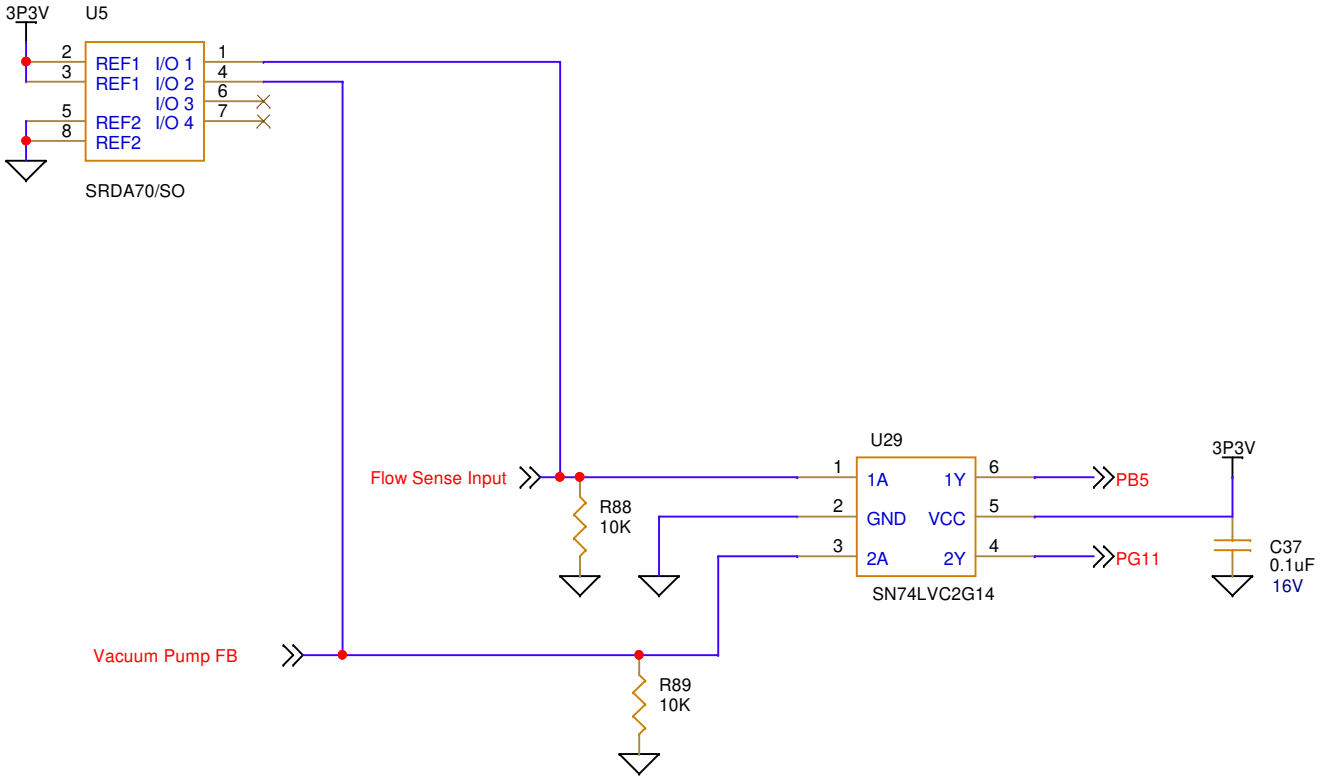


Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

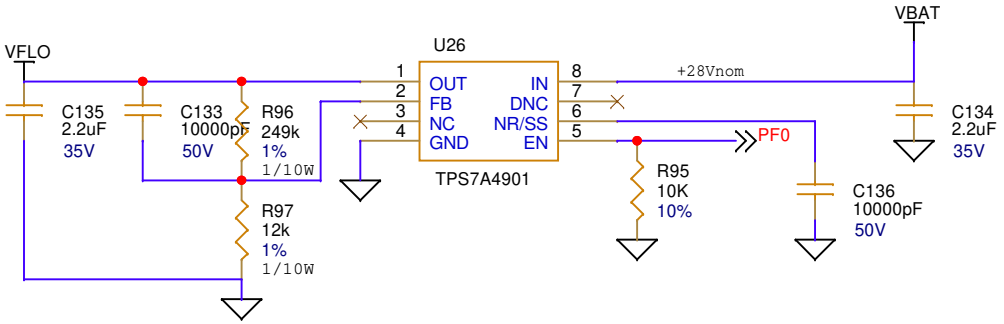
Schematic Name: ESPAquaticSampler			
Page Title: FLEXIFORCE			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 10 of 35



Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: Flow Sensor/Diaphram Pump Int			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 11 of 35

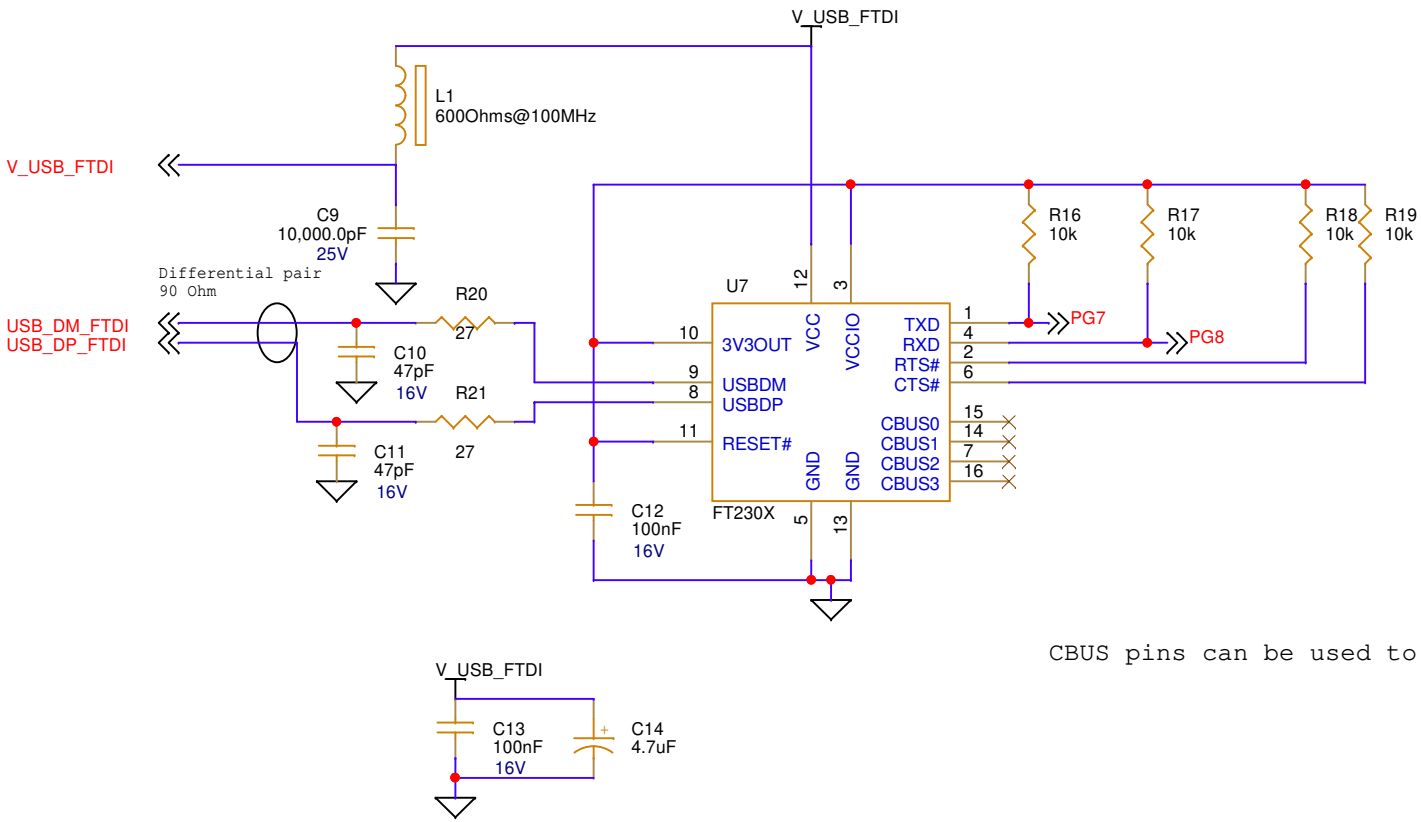
THIS IS A 36V PART!!!



VFLO= 24V for Vbus > 24.3V
VFLO= Vbus - .3 for Vbus < 24.3V

Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: FlowSensorLinearRegulator			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 12 of 35



CBUS pins can be used to drive tx,rx LEDs

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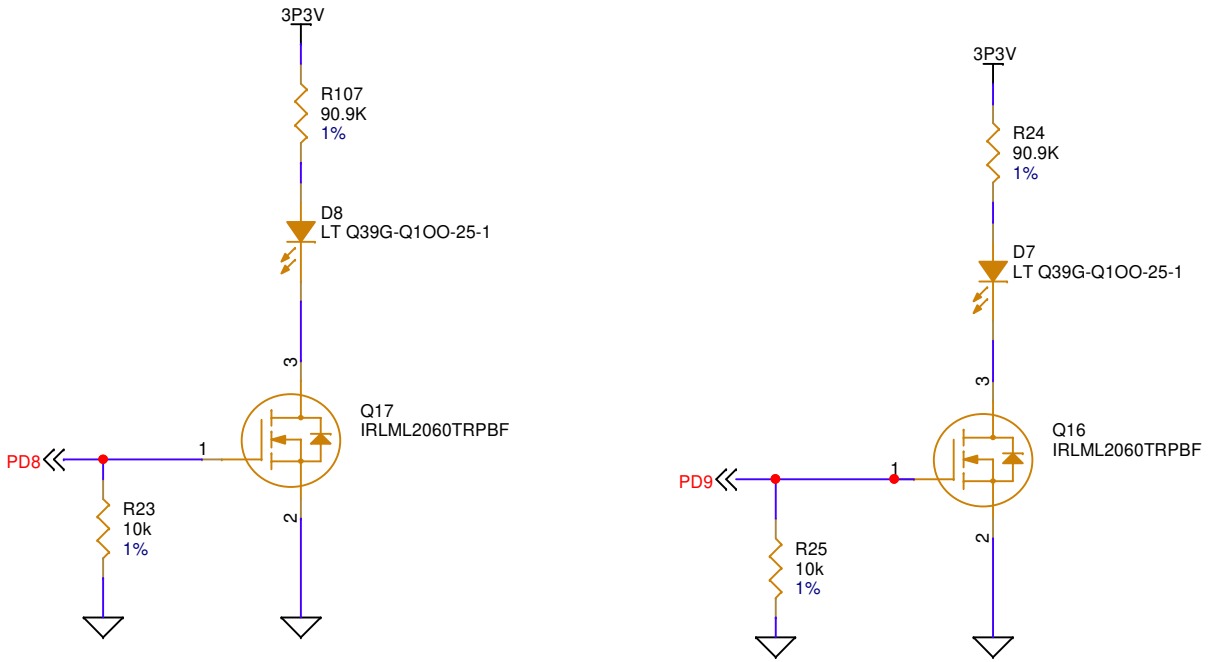
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: FTDI USB Console			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 13 of 35



Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: LED Indicators			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
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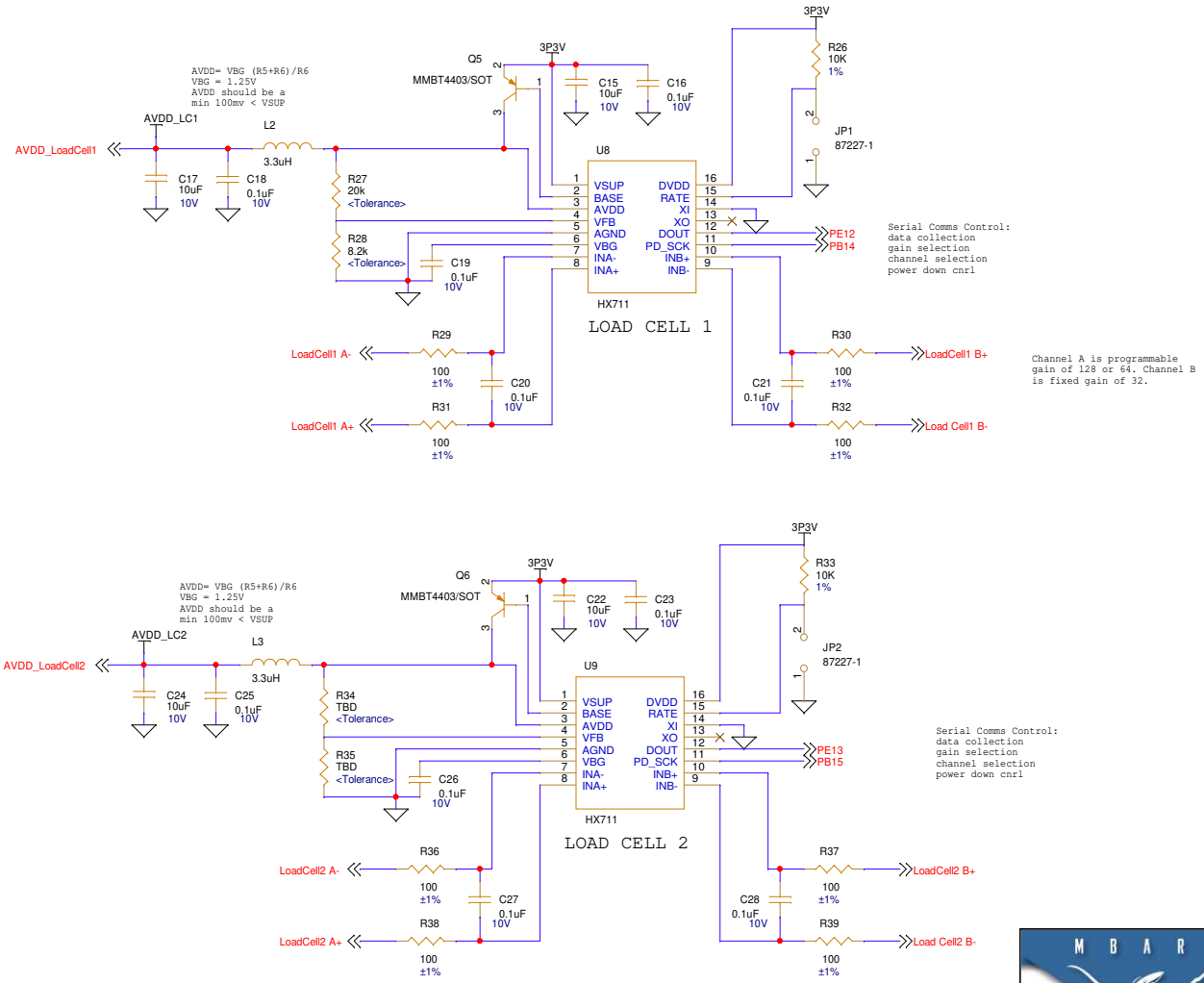
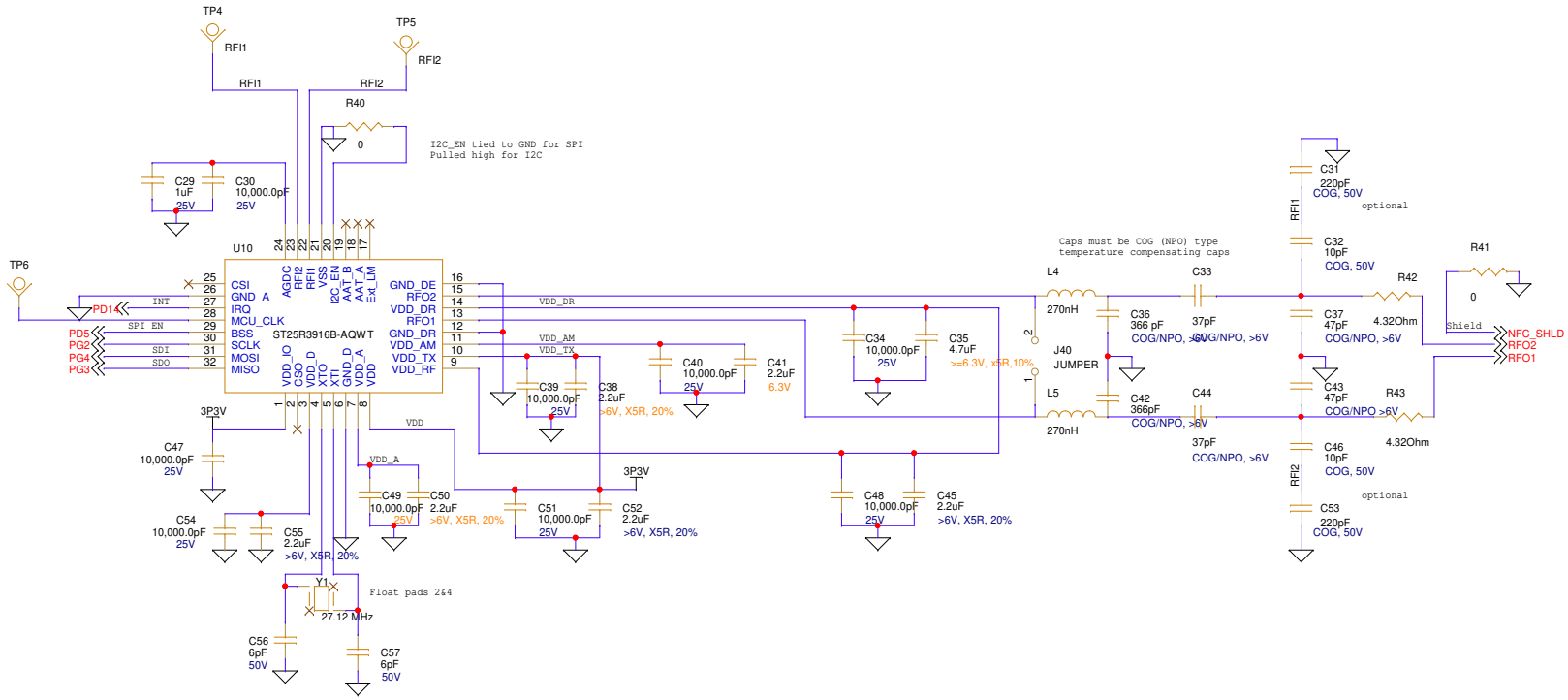


Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: LoadCells			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 15 of 35



Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name:	ESPAquaticSampler
Page Title:	NFC Reader
Engineer:	Alana Sherman
Project Name:	ESP Sampler
Group Name:	ESPSampler
Designer:	<Designer>
System:	ESP Sampler
Subsystem:	Aquatic Sampler Controller
Last Updated By:	alana
Drawing Number:	100222163 Release: A Version: 23
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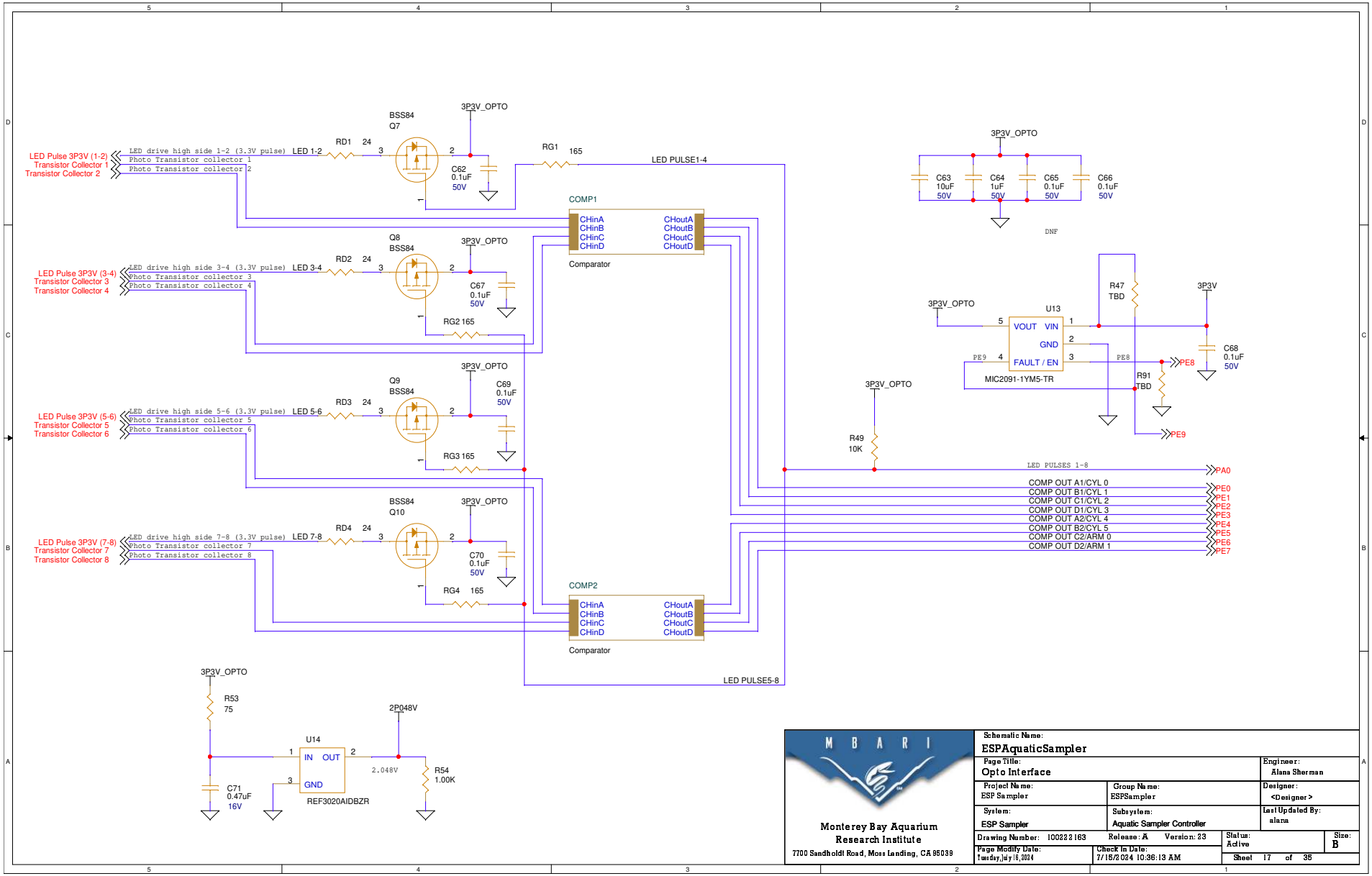

Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name:	ESPAquaticSampler
Page Title:	Opto Interface
Engineer:	Alana Sherman
Project Name:	ESP Sampler
Group Name:	ESPSampler
Designer:	<Designer>
System:	ESP Sampler
Subsystem:	Aquatic Sampler Controller
Last Updated By:	alana
Drawing Number: 10022 2163	Release: A Version: 23
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Check In Date:	7/16/2024 10:36:13 AM
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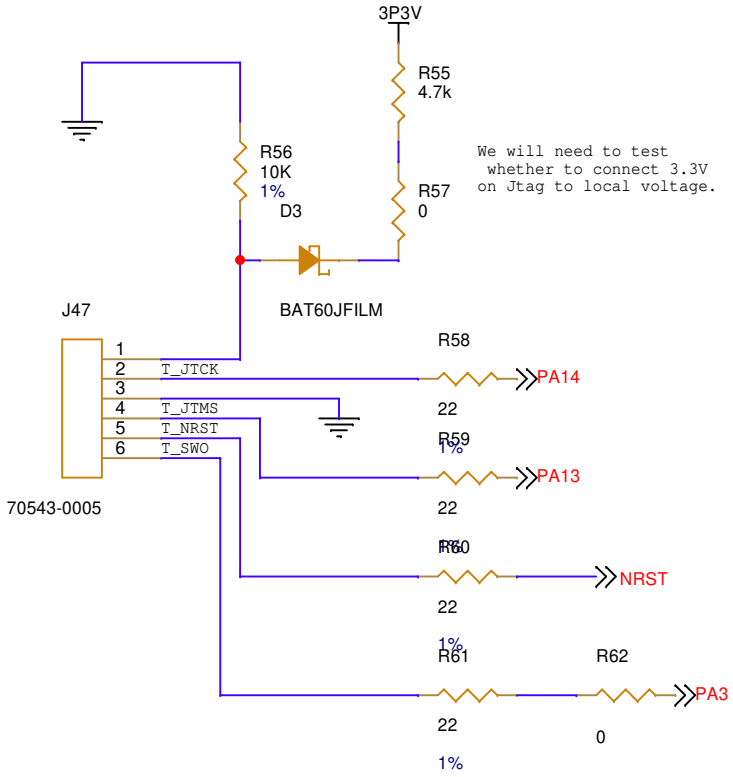

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Research Institute
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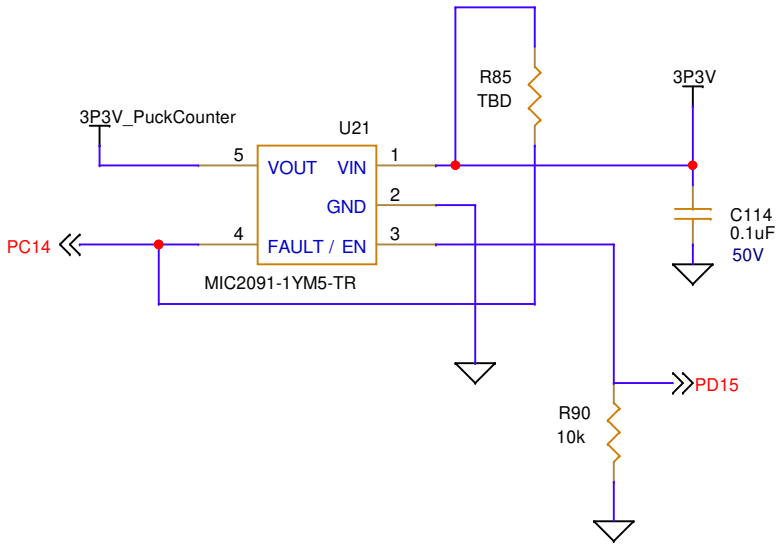
Schematic Name: ESPAquaticSampler			
Page Title: Programming Header			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 18 of 35

There is a 50mA version of this part



Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: Puck Counter Interface			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
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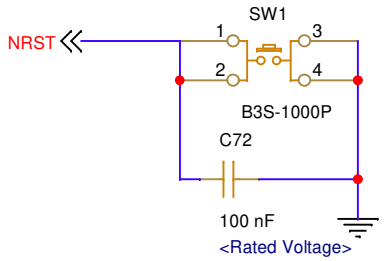
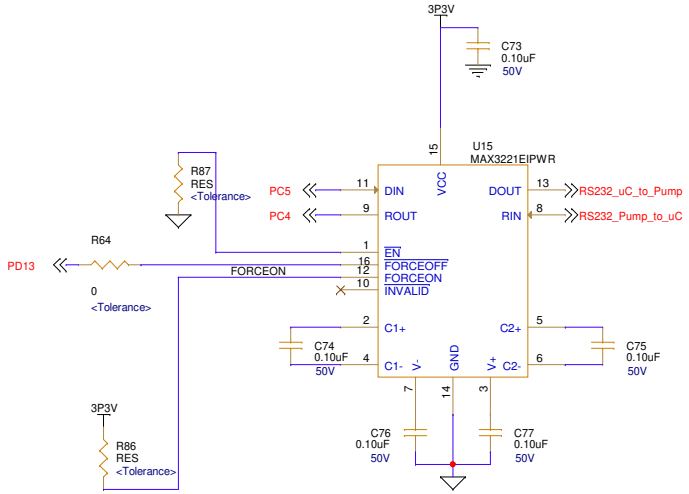


Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

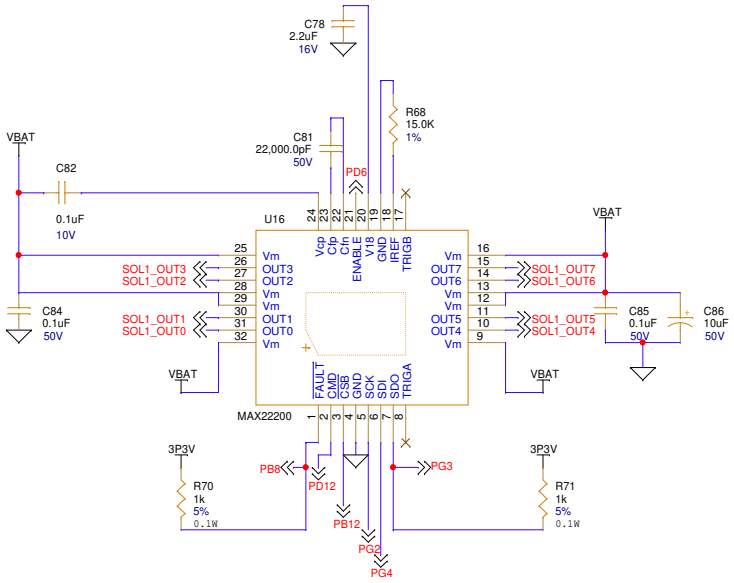
Schematic Name: ESPAquaticSampler			
Page Title: Reset Button			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 20 of 35



normal op
power down disabled

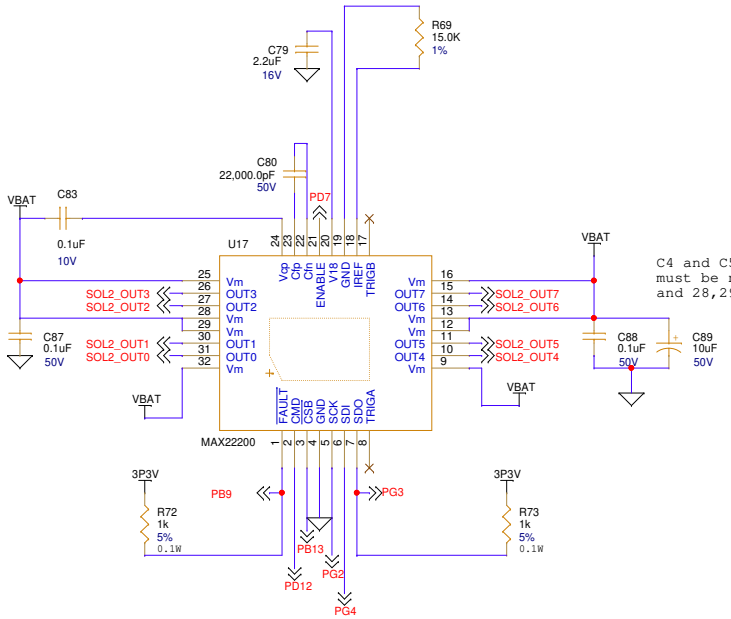
Monterey Bay Aquarium Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler			
Page Title: Sample Pump Comms			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Tuesday, July 16, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 21 of 35



Solenoids 1-8

IRef Circuit ground must
be kept short and ground should
be connected to ground pin



C4 and C5 (0.1 uF bypass caps)
must be near pins 12, 13
and 28,29 respectively

Solenoids 9-16

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Research Institute
7700 Sandholdt Road, Moss Landing, CA 95039

Schematic Name: ESPAquaticSampler

Page Title: Solenoid Drivers

Engineer: Alana Sherman

Project Name: ESP Sampler

Group Name: ESPSampler

Designer: <Designer>

System: ESP Sampler

Subsystem: Aquatic Sampler Controller

Last Updated By: alana

Drawing Number: 100222163 Release: A Version: 23

Status: Active

Size: B

Page Modify Date: Tuesday, July 16, 2024

Check In Date: 7/15/2024 10:36:13 AM

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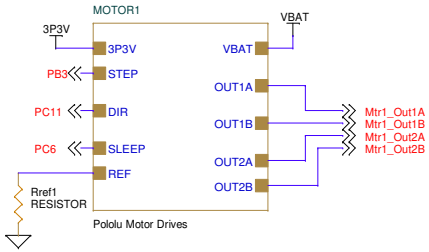
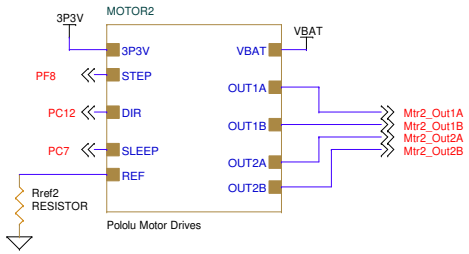
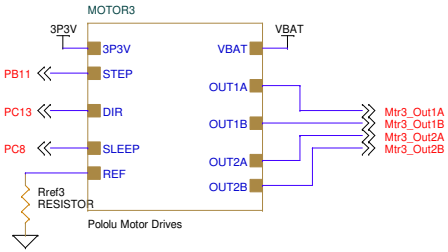
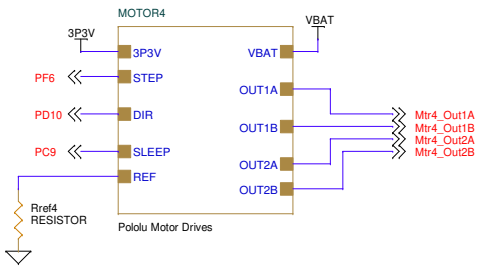
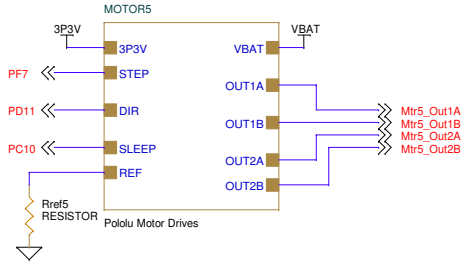






bring another port out for VREF
attach resistor to set current to pin





Another way to set the current limit is to calculate the reference voltage that corresponds to your desired current limit and then adjust the current limit potentiometer until you measure that voltage on the **VREF** pin. The VREF pin voltage is accessible on a via that is circled on the bottom silkscreen of the circuit board. The current limit, I_{MAX}, relates to the reference voltage as follows:

$$I_{MAX} = \frac{V_{REF}}{8 \cdot R_{CS}}$$

or, rearranged to solve for VREF:

$$V_{REF} = 8 \cdot I_{MAX} \cdot R_{CS}$$

R_{CS} is the current sense resistance, and all units manufactured since 2017 have **0.068 Ω** current sense resistors (units made prior to this had green 0.050 Ω sense resistors). So, for example, if you want to set the current limit to 1 A, you would set VREF to 540 mV. Doing this ensures that even though the current through each coil changes from step to step, the magnitude of the current vector in the stepper motor stays constant at 1 A:

$$\sqrt{I_{COIL1}^2 + I_{COIL2}^2} = I_{MAX} = 1\text{A}$$

If you instead want the current through *each coil* to be 1 A in full-step mode, you would need to set the current limit to be 40% higher, or 1.4 A, since the coils are limited to approximately 70% of the set current limit in full-step mode (the equation above shows why this is the case). This can be accomplished by setting VREF to 770 mV.

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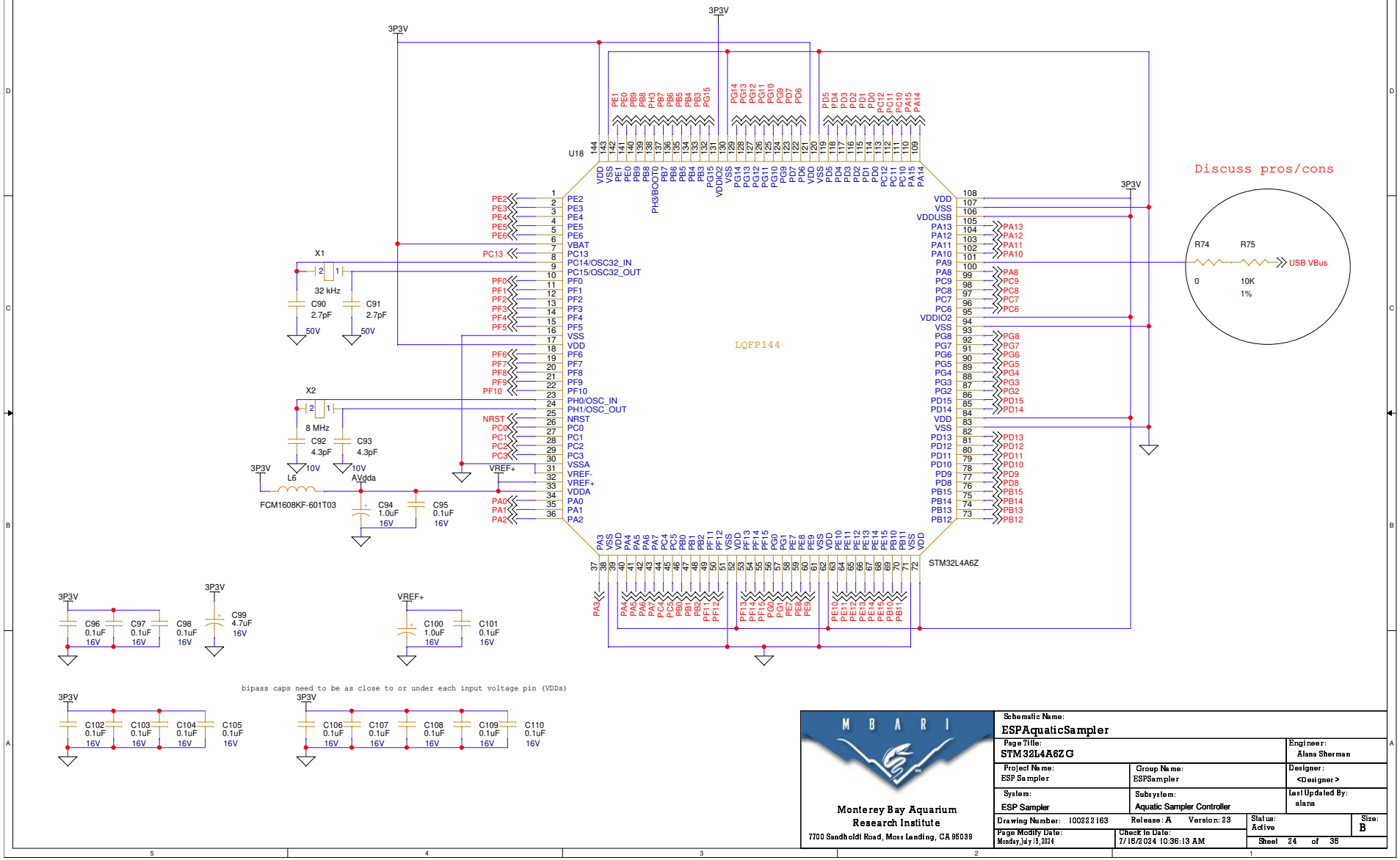
Schematic Name: ESPAquaticSampler			
Page Title: Stepper Motor Drives			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: B
Page Modify Date: Monday, May 6, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 23 of 35



Schematic Name:	ESPAquaticSampler
Page Title:	STM32L4A6ZG
Engineer:	Alana Sherman
Project Name:	ESP Sampler
Group Name:	ESPSampler
Designer:	<Designer>
System:	ESP Sampler
Subsystem:	Aquatic Sampler Controller
Last Updated By:	alana
Drawing Number:	100222163
Release:	A
Version:	23
Status:	Active
Size:	B
Page Modify Date:	Monday, July 15, 2024
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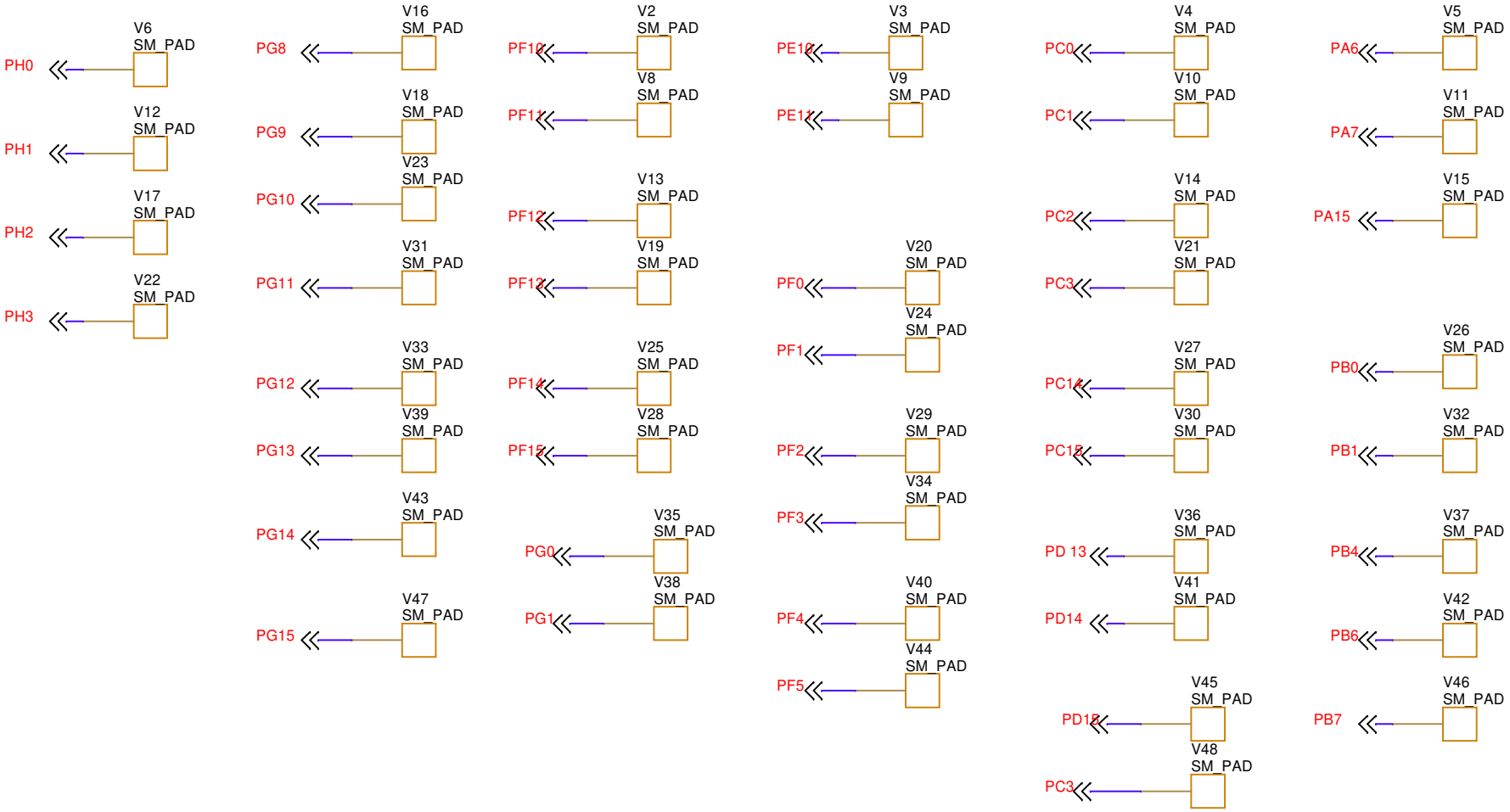

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Schematic Name: ESPAquaticSampler
Page Title: Unused MCU pins
Engineer: Alana Sherman
Project Name: ESP Sampler
Group Name: ESPSampler
Designer: <Designer>
System: ESP Sampler
Subsystem: Aquatic Sampler Controller
Last Updated By: alana
Drawing Number: 100222163 Release: A Version: 23
Status: Active
Size: A
Page Modify Date: Monday, July 15, 2024
Check In Date: 7/15/2024 10:36:13 AM
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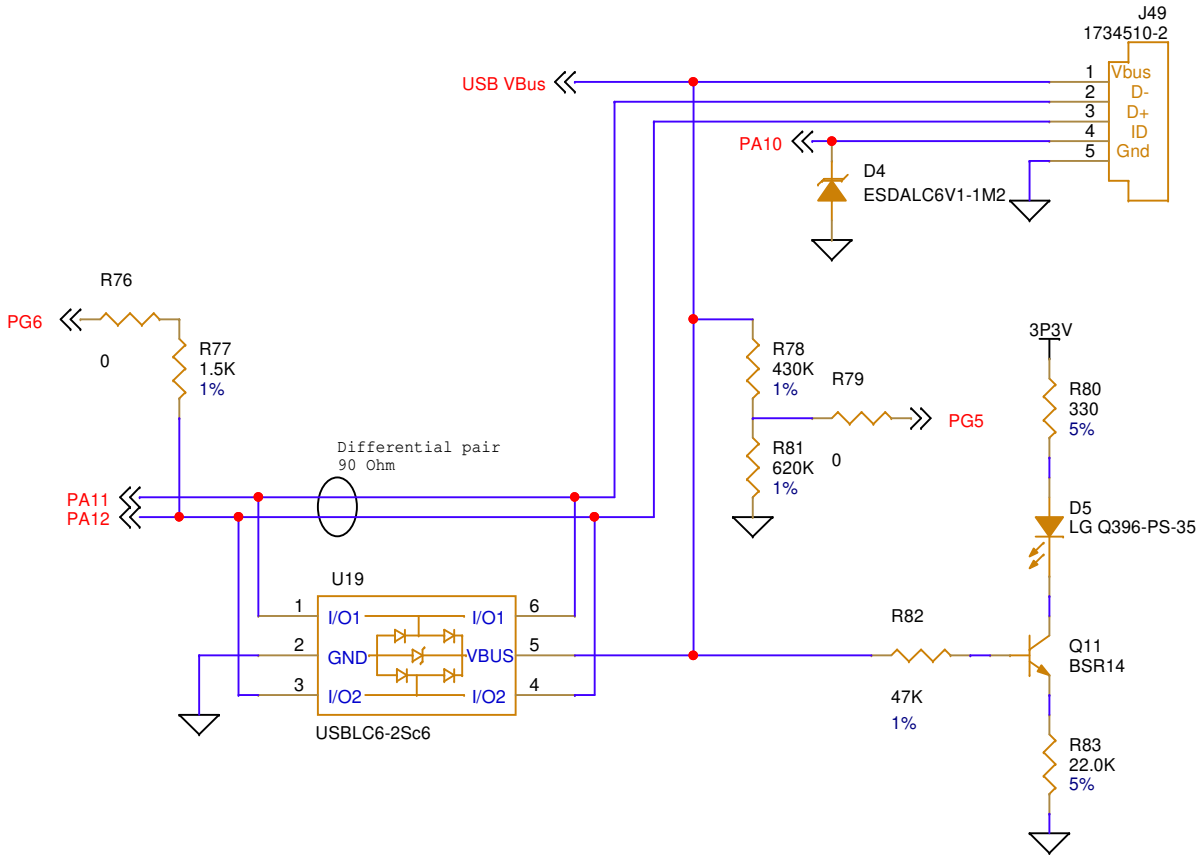

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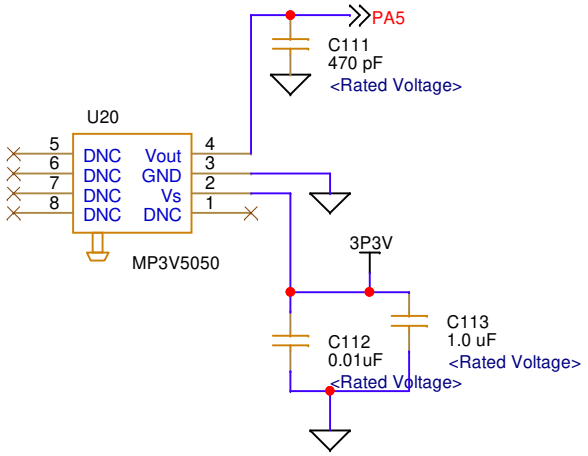
Schematic Name: ESPAquaticSampler			
Page Title: USB Python Console			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 26 of 35



Need to add switch to power
pressure sensor off, enable is pin

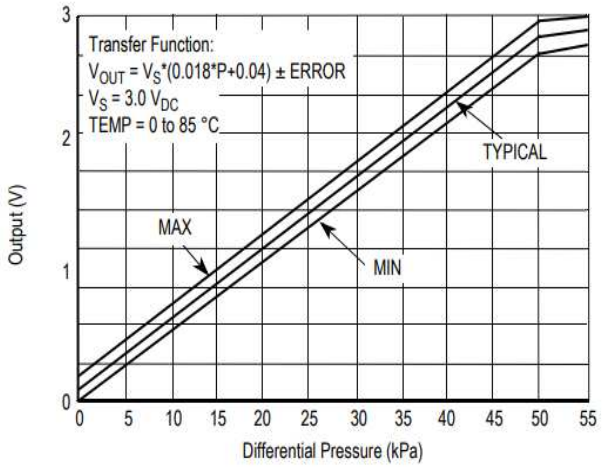


Figure 3. Output versus Pressure differential

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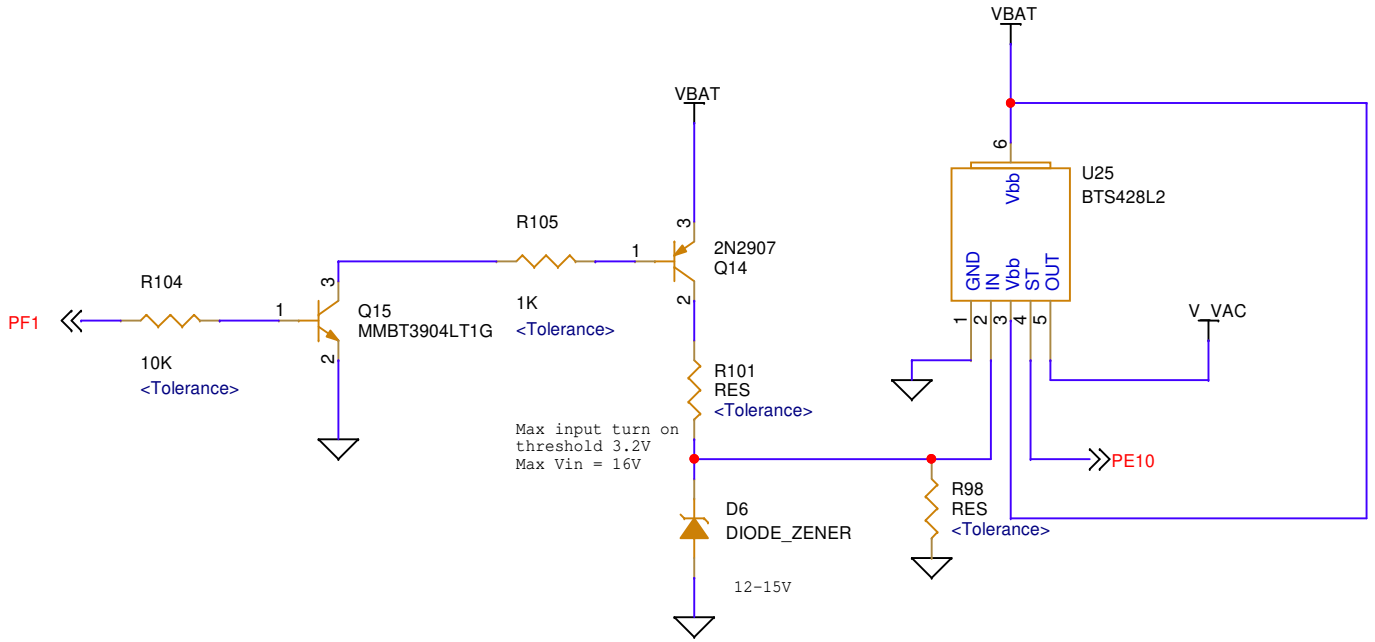
Schematic Name: ESPAquaticSampler			
Page Title: Vacuum Pressure Sensor			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
Page Modify Date: Monday, July 15, 2024	Check In Date: 7/15/2024 10:36:13 AM		Sheet 27 of 35



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Schematic Name: ESPAquaticSampler			
Page Title: Vacuum Pump Pwr Switch			Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler		Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller		Last Updated By: alana
Drawing Number: 100222163	Release: A	Version: 23	Status: Active / Size: A
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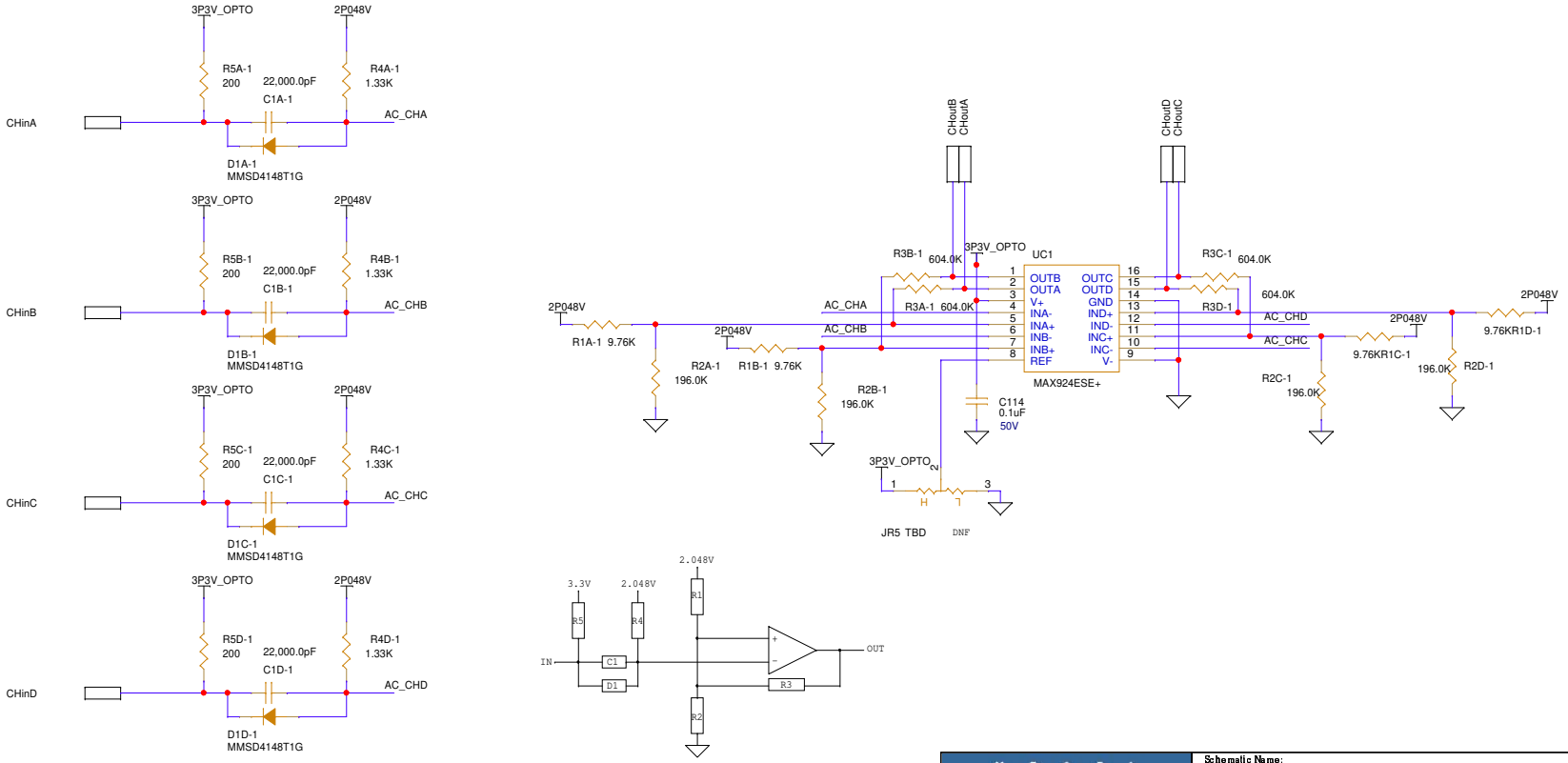

Schematic Name:	Comparator
Page Title:	Quad Comparator
Engineer:	Alana Sherman
Project Name:	ESP Sampler
Group Name:	ESPSampler
Designer:	<Designer>
System:	ESP Sampler
Subsystem:	Aquatic Sampler Controller
Last Updated By:	alana
Drawing Number: 100222163	Release: A Version: 23
Status:	Active
Size:	B
Page Modify Date:	Monday, July 8, 2024
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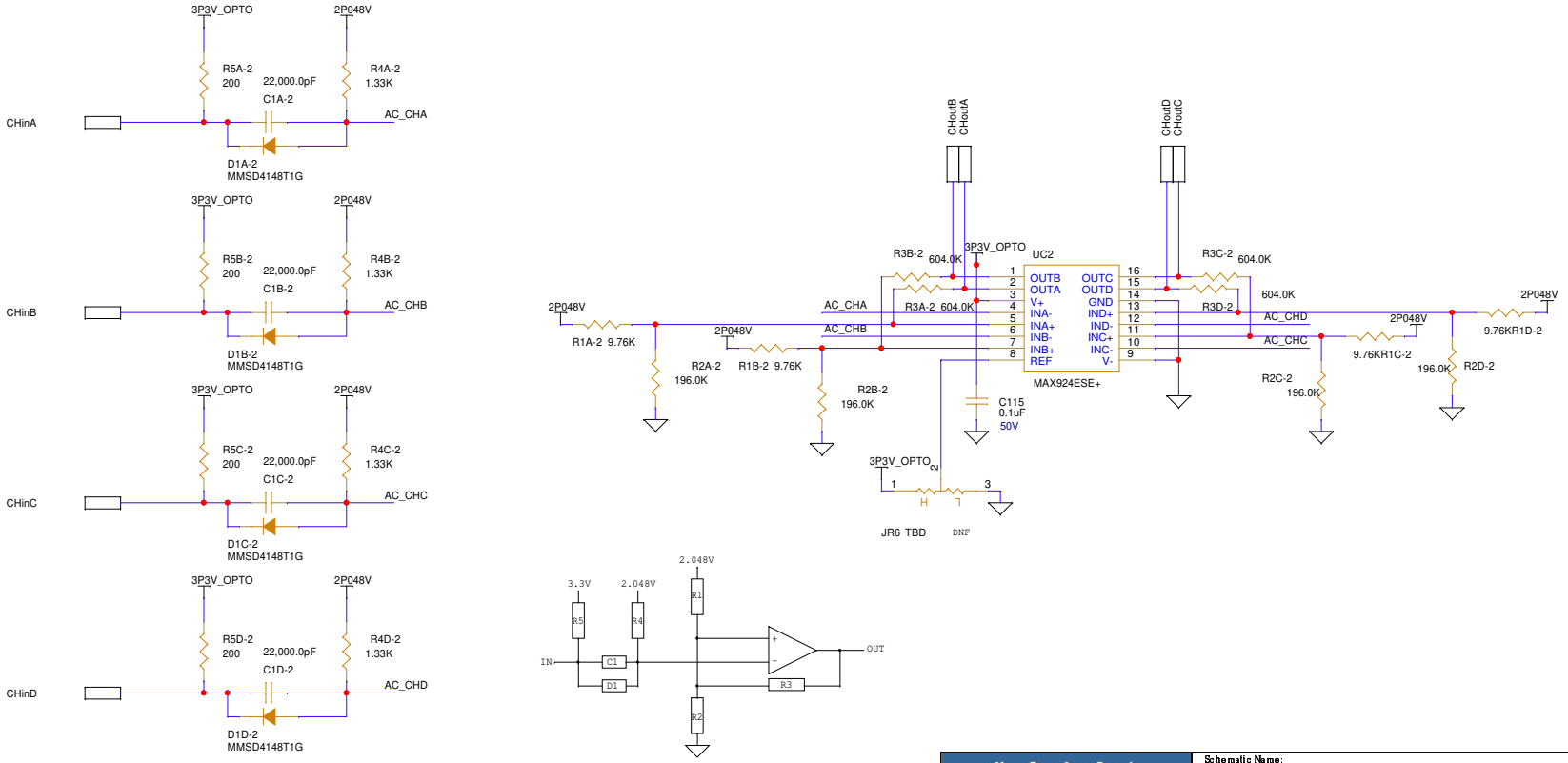
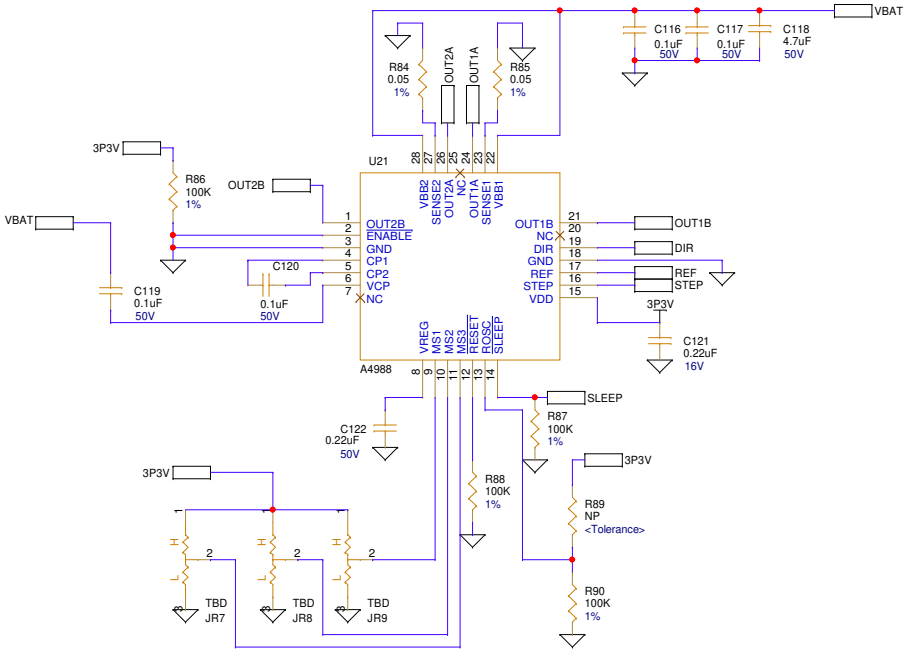


Monterey Bay Aquarium Research Institute 7700 Sandholdt Road, Moss Landing, CA 95039	Schematic Name: Comparator	
	Page Title: Quad Comparator	Engineer: Alana Sherman
	Project Name: ESP Sampler Group Name: ESPSampler	Designer: <Designer>
	System: ESP Sampler Subsystem: Aquatic Sampler Controller	Last Updated By: alana
	Drawing Number: 100222163 Release: A Version: 23	Status: Active Size: B
	Page Modify Date: Monday, July 8, 2024 Check In Date: 7/15/2024 10:36:13 AM	Sheet 30 of 35



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Schematic Name: Pololu Motor Drives
Page Title: Pololu A4988
Engineer: Alana Sherman
Project Name: ESP Sampler
Group Name: ESPSampler
Designer: <Designer>
System: ESP Sampler
Subsystem: Aquatic Sampler Controller
Last Updated By: alana
Drawing Number: 100222163
Release: A
Version: 23
Status: Active
Size: B
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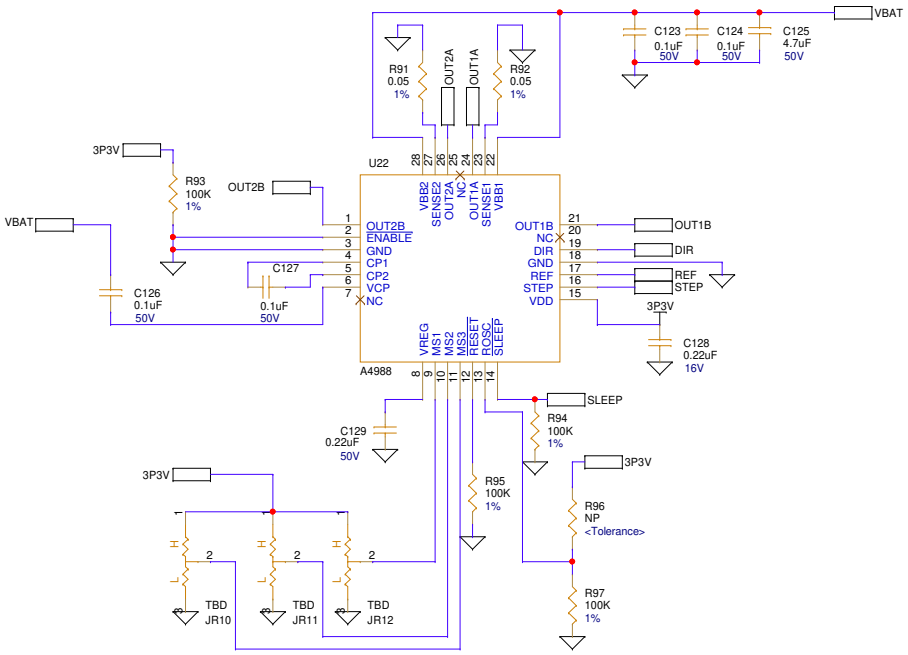

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Schematic Name: Pololu Motor Drives

Page Title: Pololu A4988		Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler	Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller	Last Updated By: alana
Drawing Number: 1002221 63 Release: A Version: 23		Status: Active / Size: B
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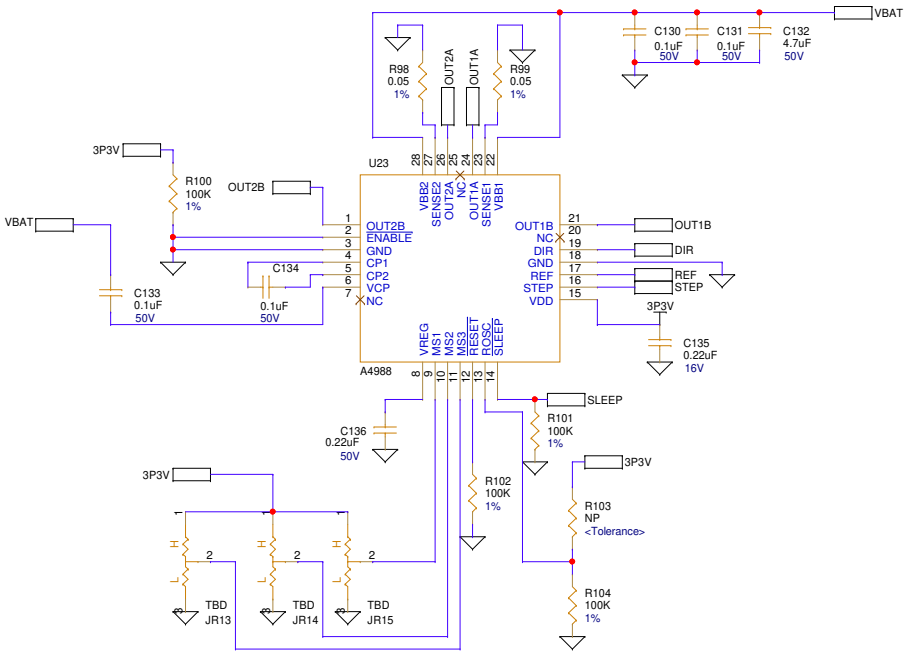

Schematic Name:	Pololu Motor Drives
Page Title:	Pololu A4988
Engineer:	Alana Sherman
Project Name:	ESP Sampler
Group Name:	ESPSampler
Designer:	<Designer>
System:	ESP Sampler
Subsystem:	Aquatic Sampler Controller
Last Updated By:	alana
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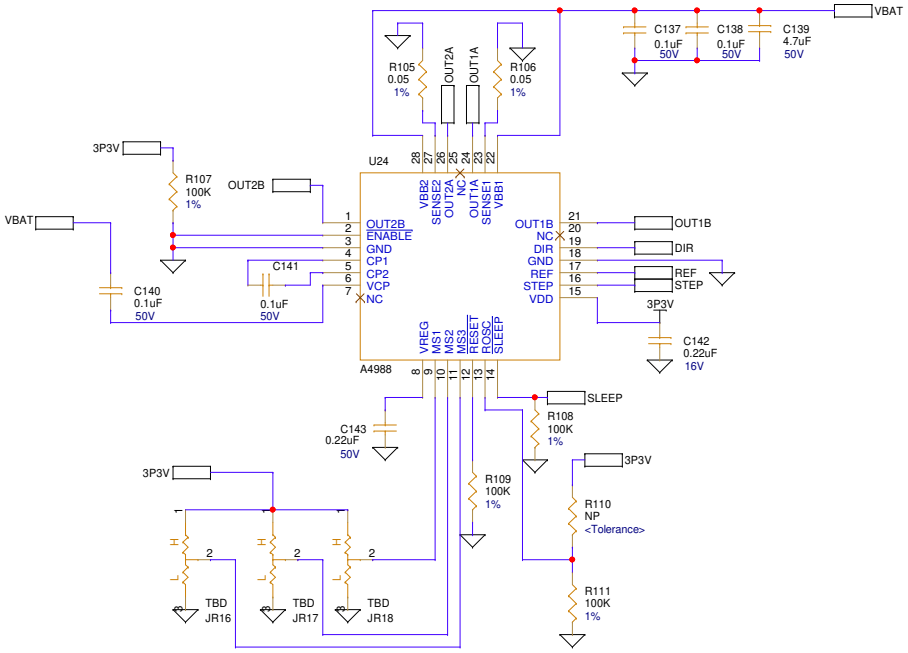

Schematic Name:	Pololu Motor Drives
Page Title:	Pololu A4988
Engineer:	Alana Sherman
Project Name:	ESP Sampler
Group Name:	ESPSampler
Designer:	<Designer>
System:	ESP Sampler
Subsystem:	Aquatic Sampler Controller
Last Updated By:	alana
Drawing Number:	100222163
Release:	A
Version:	23
Status:	Active
Size:	B
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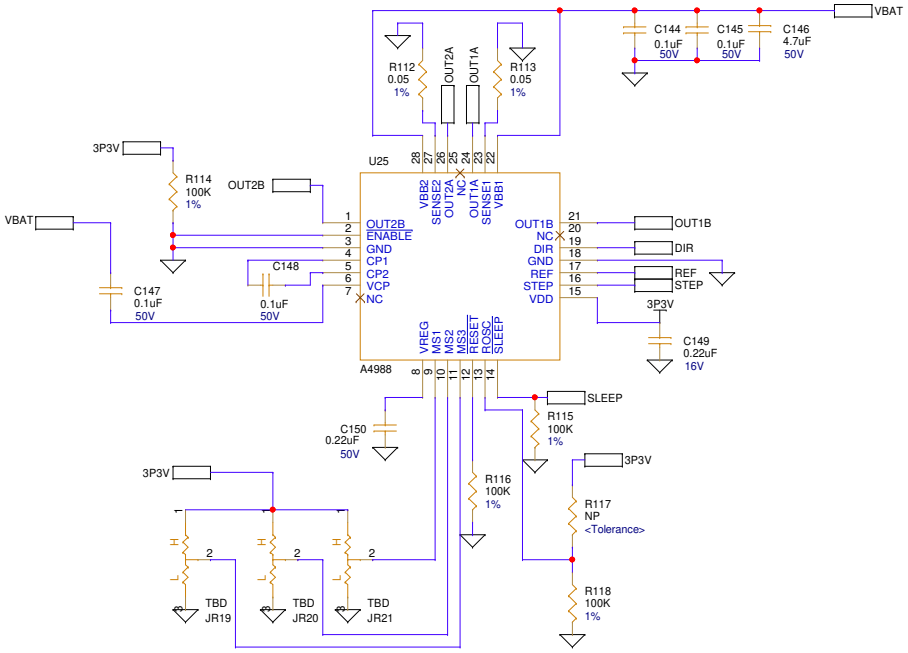

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Schematic Name: Pololu Motor Drives

Page Title: Pololu A4988		Engineer: Alana Sherman
Project Name: ESP Sampler	Group Name: ESPSampler	Designer: <Designer>
System: ESP Sampler	Subsystem: Aquatic Sampler Controller	Last Updated By: alana
Drawing Number: 100222163 Release: A Version: 23		Status: Active / Size: B
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