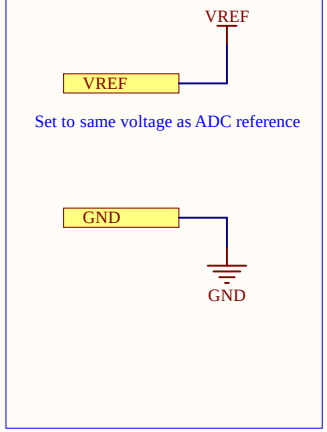
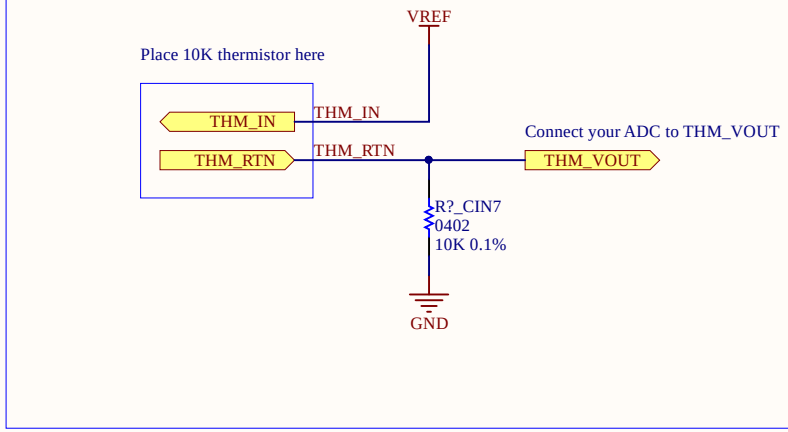
POWER INPUTS



THERMISTOR



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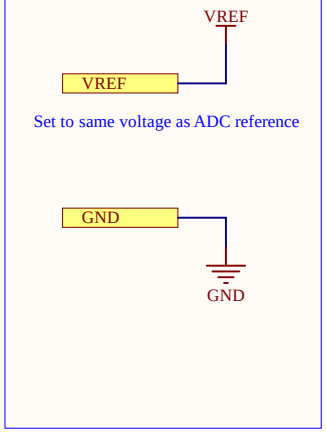
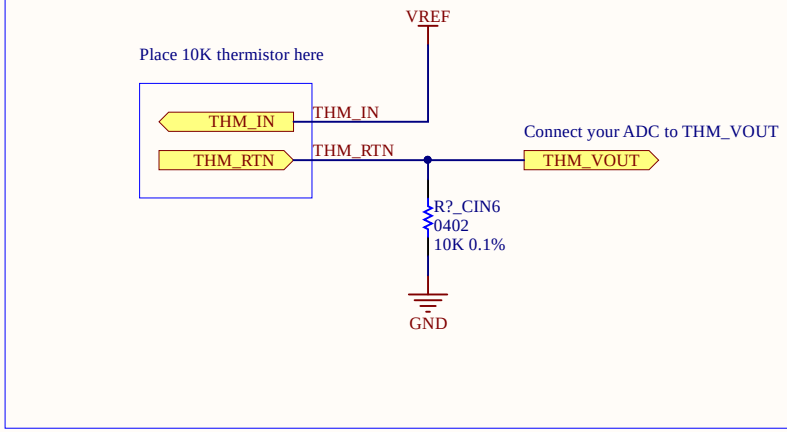
Size: A4	Number: PCBS-COMMON	Revision: 1.2
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



THERMISTOR



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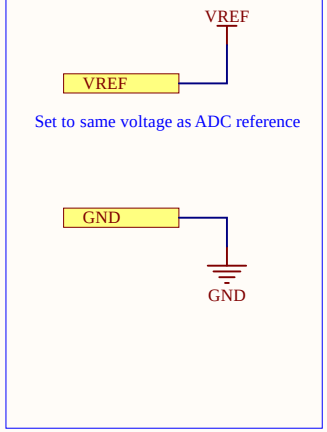
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



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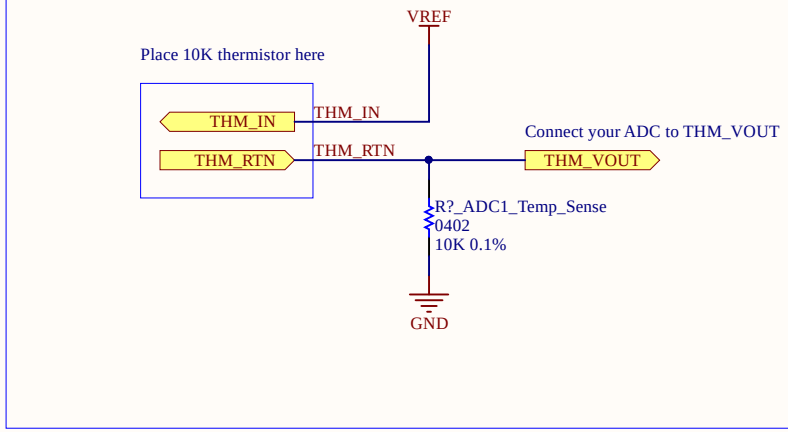

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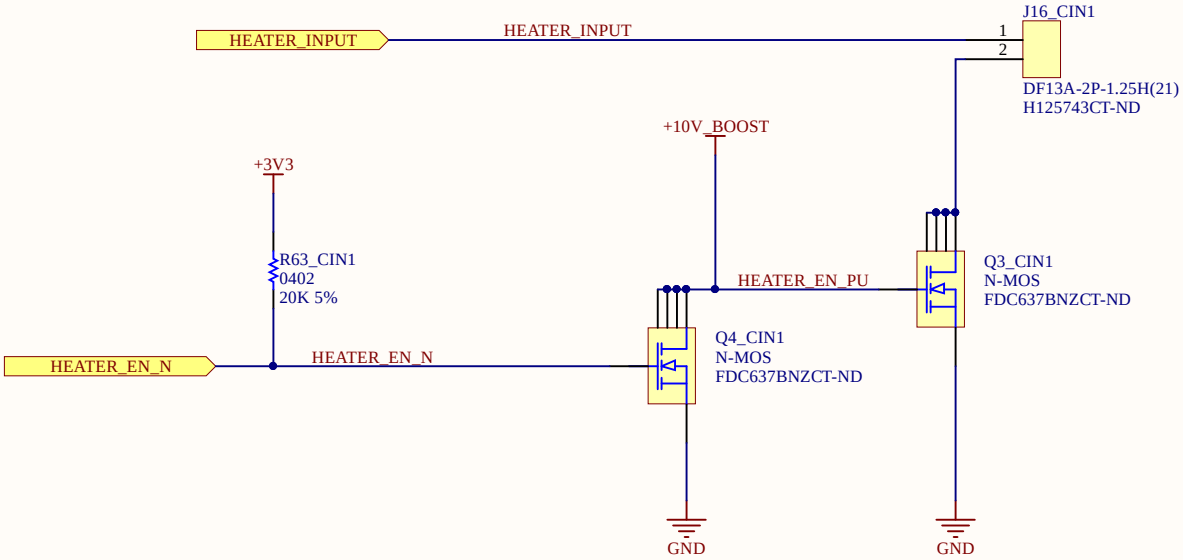
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	



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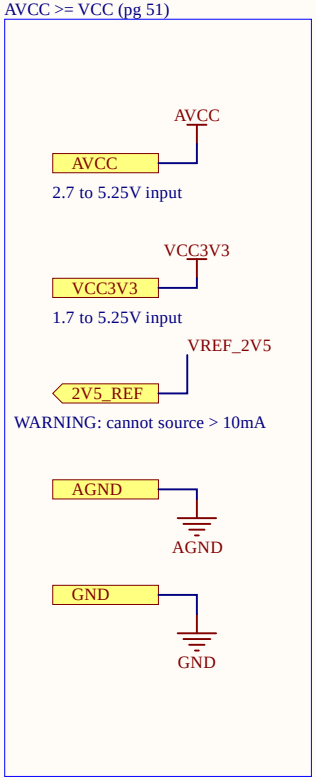
Size: A4	Number	Revision
Date: 2019-07-24		Sheet of
File: C:\Users\..\heaters-connectors.SchDoc		Drawn By:

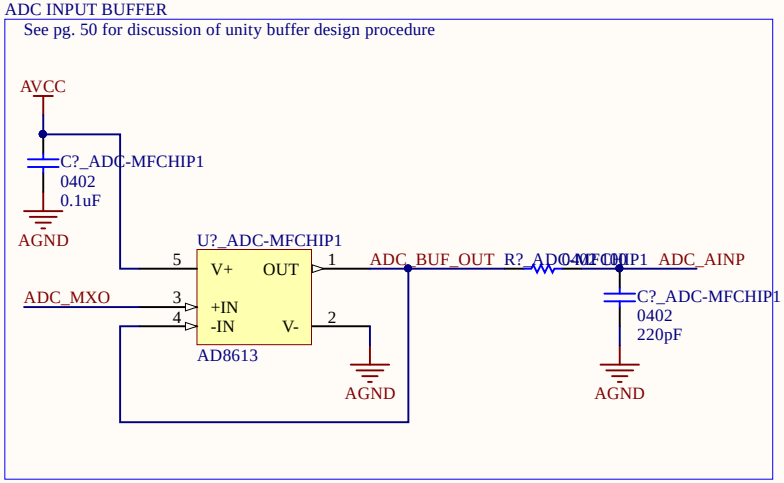
POWER PORTS

AVCC >= VCC (pg 51)



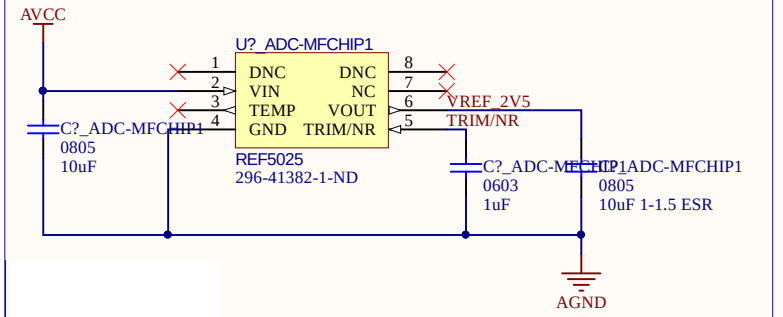
ADC INPUT BUFFER

See pg. 50 for discussion of unity buffer design procedure

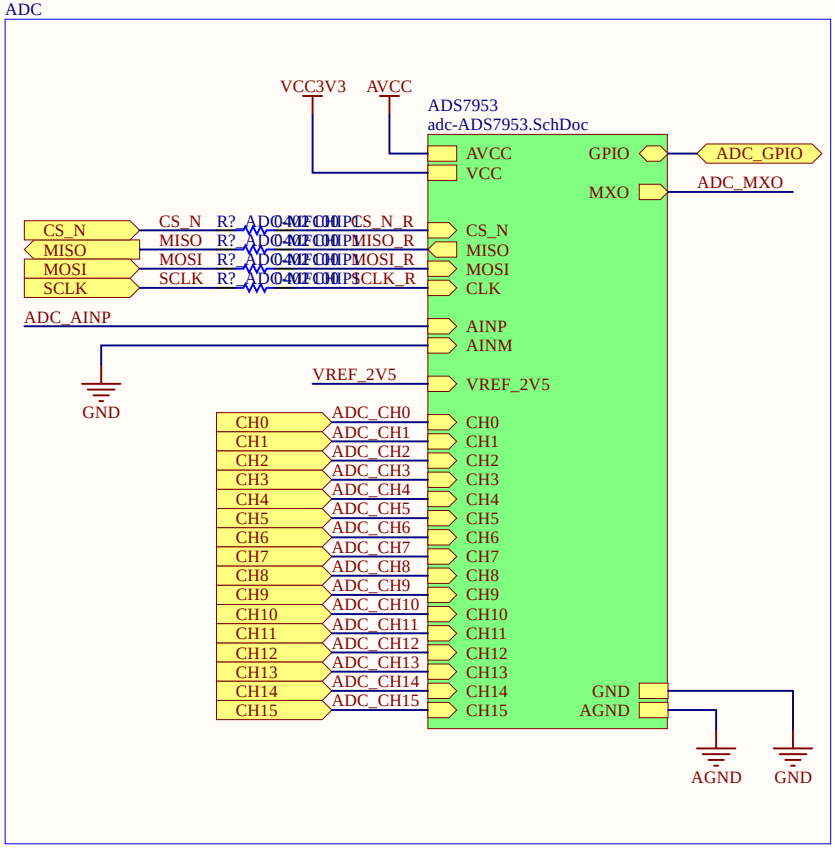


2V5 REFERENCE

Output cap should have ESR from 1 - 1.5 ohm (see pg. 21)



ADC



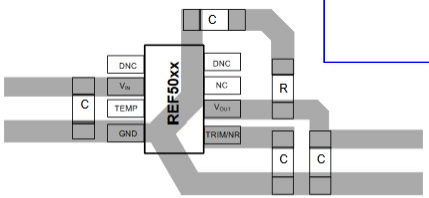


Figure 44. Layout Example

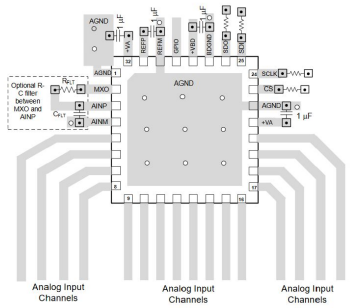


Figure 70. Recommended Layout for the VQFN Packaged Device

This schematic implements the ADS7953 analog-to-digital converter with a 2.5V reference and a unity-gain buffer on the output of the internal multiplexer.
- Recommended input impedance should be < 1K. Higher source impedances possible with slower sampling.
- Breaks out 2V5 for use as reference outside the circuit
- All necessary bypassing and pull-ups implemented in the ADS7953 schematic
- In most low-performance applications, AVCC and VCC can be tied together
- In the layout, the pins tied to AGND should be put on a local GND pour and then tied to the global ground plane with low-impedance.
- 100 ohm resistors on the SPI input help to isolate the ADC from digital noise

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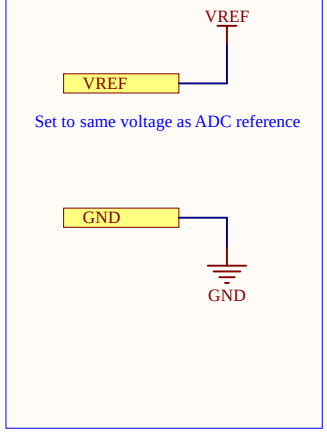
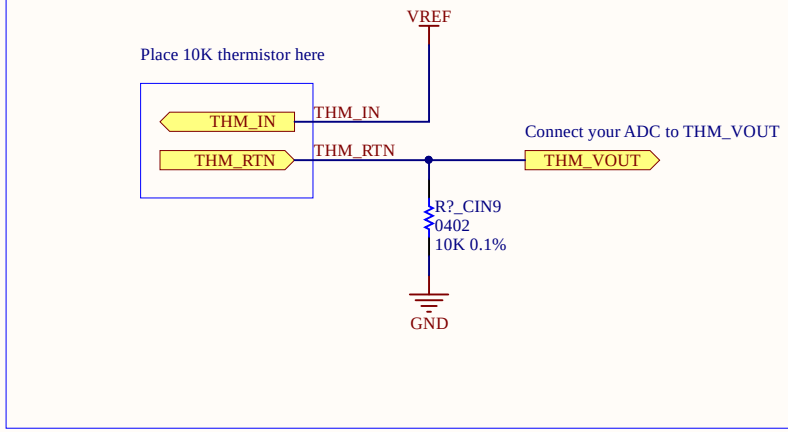
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\adc-circuit-ADS7953.SchDoc	Drawn By: Dylan Vogel	

POWER INPUTS



THERMISTOR



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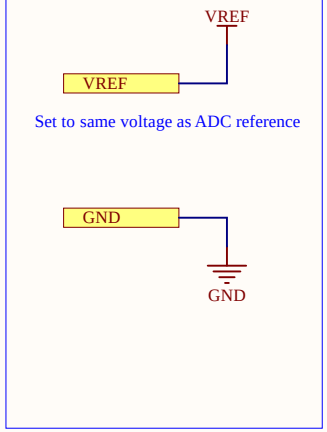
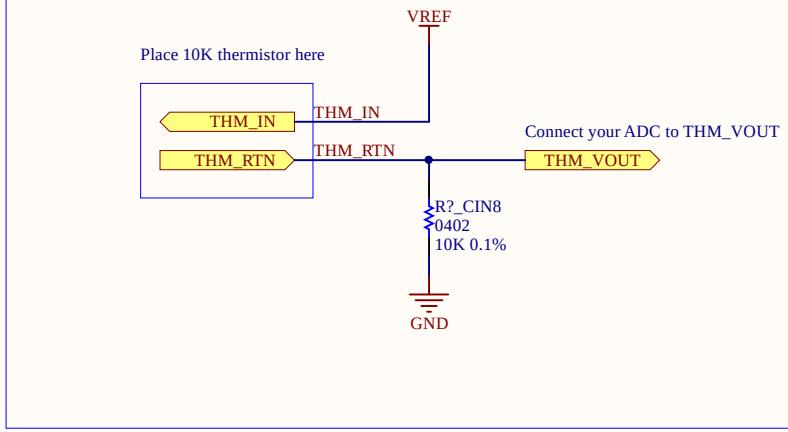
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



THERMISTOR



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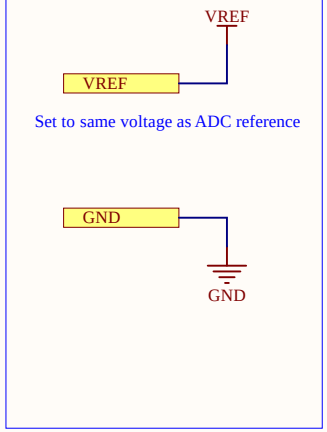
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



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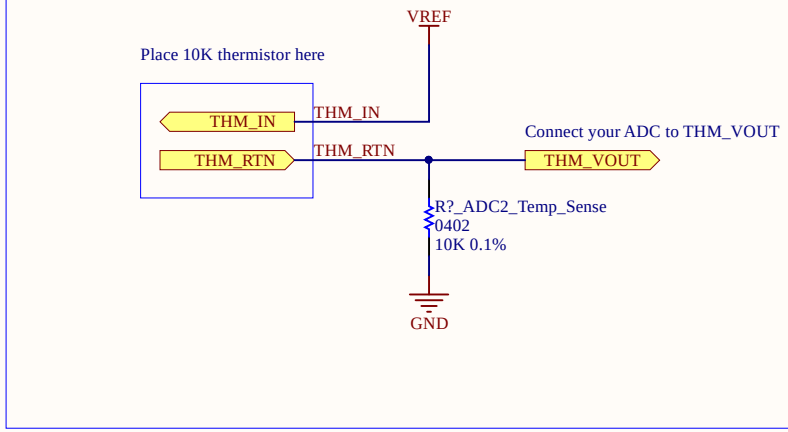

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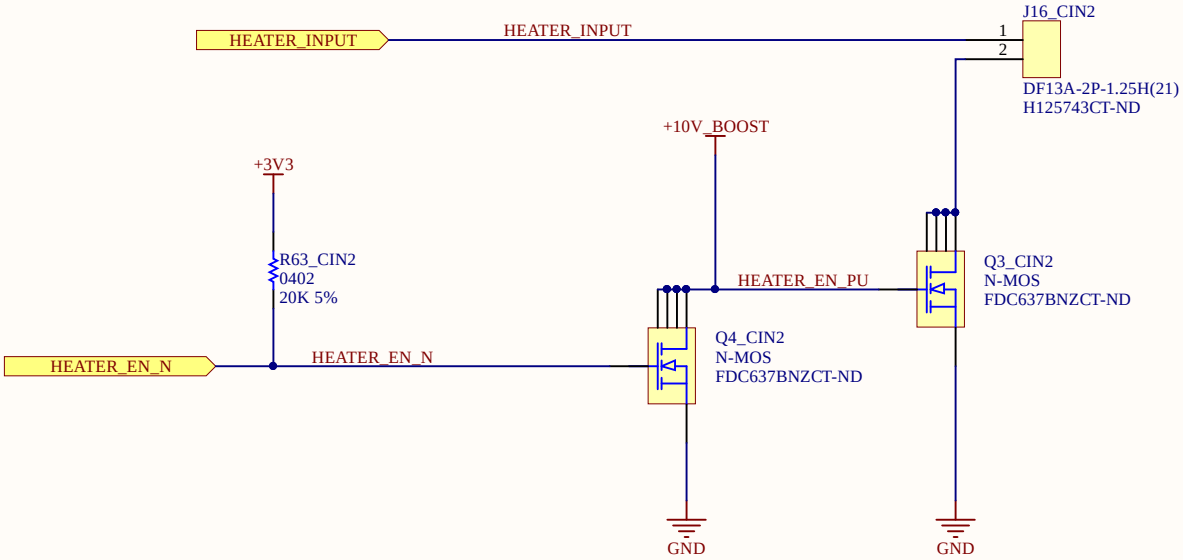
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	



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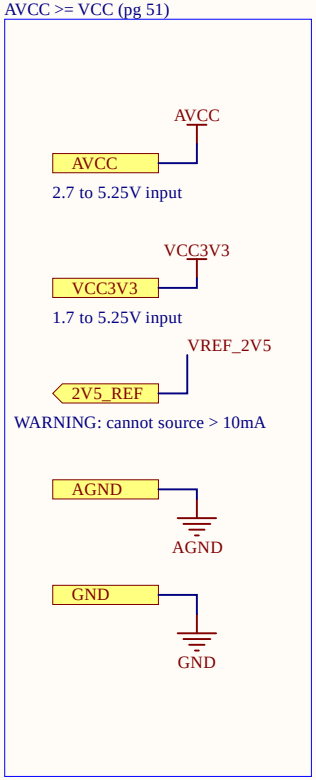
Size: A4	Number	Revision
Date: 2019-07-24		Sheet of
File: C:\Users\..\heaters-connectors.SchDoc		Drawn By:

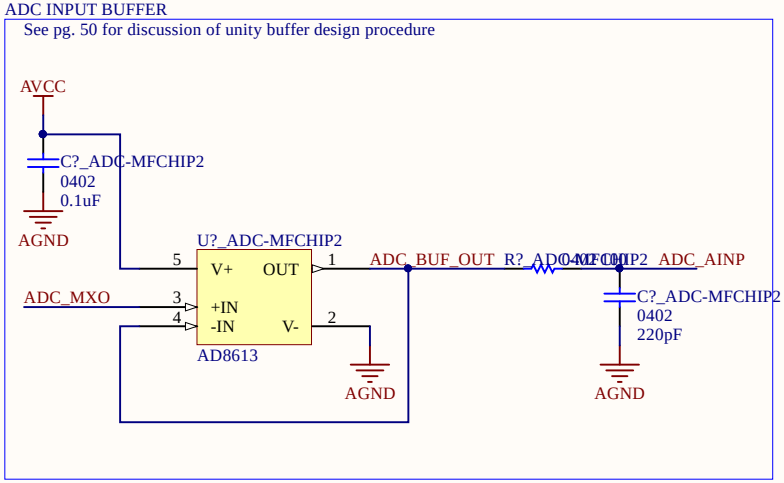
POWER PORTS

AVCC >= VCC (pg 51)



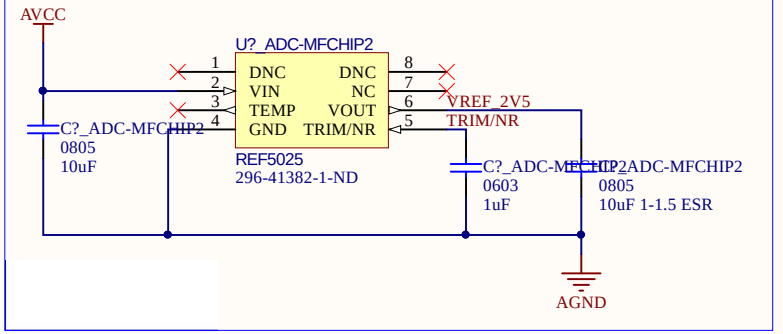
ADC INPUT BUFFER

See pg. 50 for discussion of unity buffer design procedure

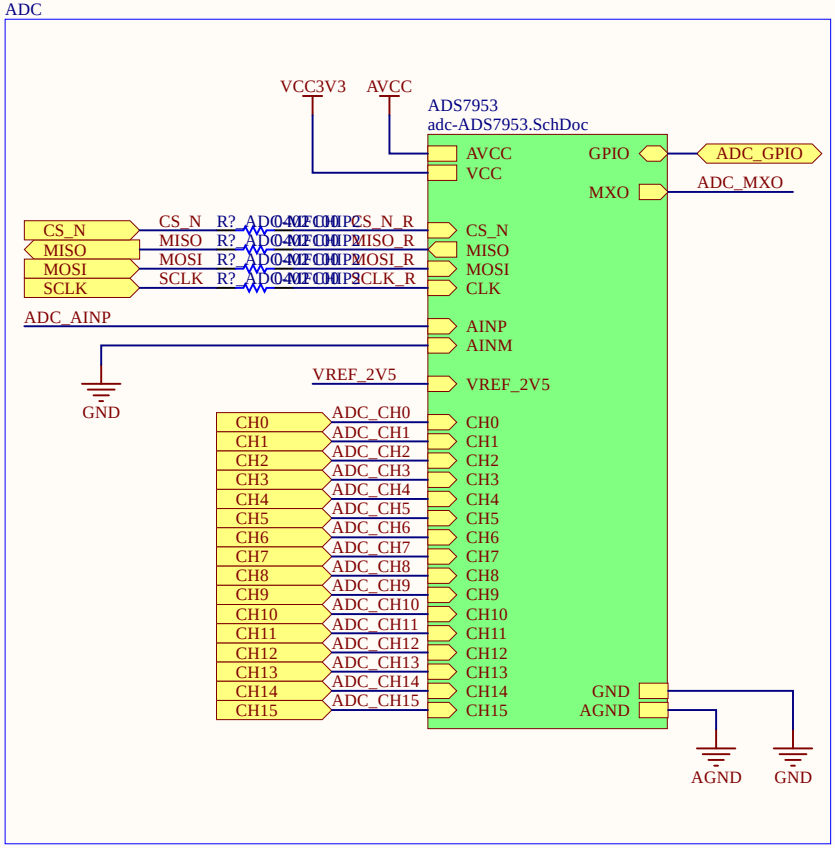


2V5 REFERENCE

Output cap should have ESR from 1 - 1.5 ohm (see pg. 21)



ADC



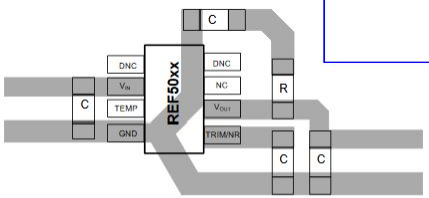


Figure 44. Layout Example

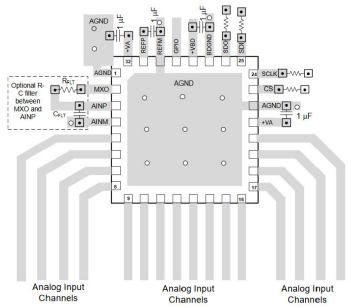


Figure 70. Recommended Layout for the VQFN Packaged Device

This schematic implements the ADS7953 analog-to-digital converter with a 2.5V reference and a unity-gain buffer on the output of the internal multiplexer.
- Recommended input impedance should be < 1K. Higher source impedances possible with slower sampling.
- Breaks out 2V5 for use as reference outside the circuit
- All necessary bypassing and pull-ups implemented in the ADS7953 schematic
- In most low-performance applications, AVCC and VCC can be tied together
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File: C:\Users\..\adc-circuit-ADS7953.SchDoc	Drawn By: Dylan Vogel	

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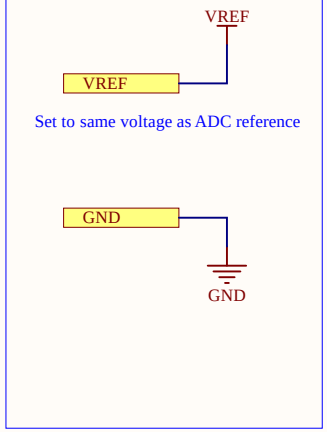
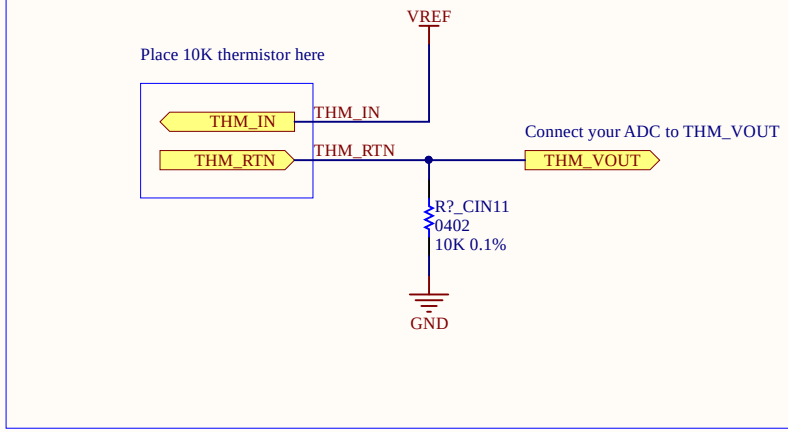


THERMISTOR



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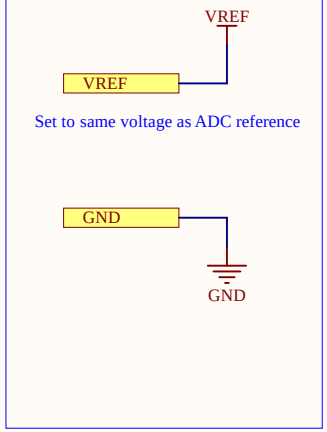
POWER INPUTS



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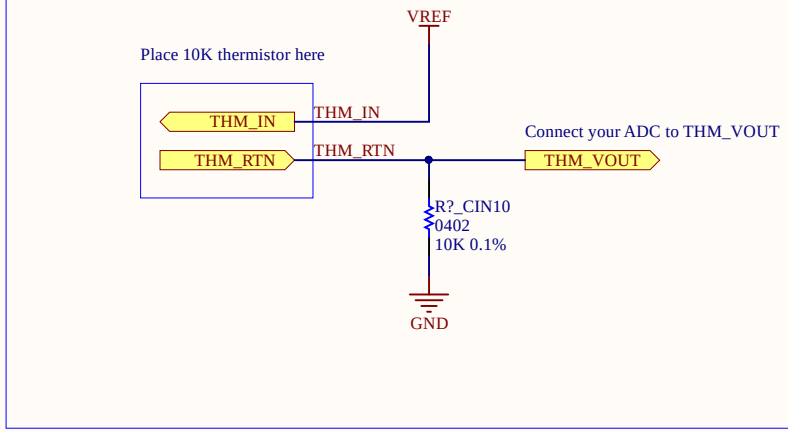

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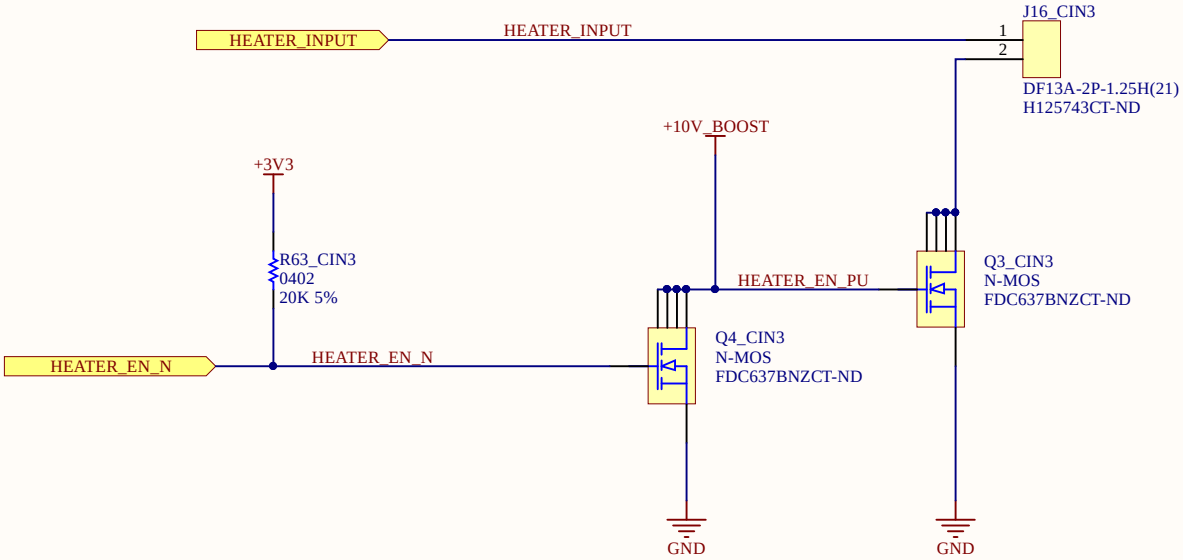

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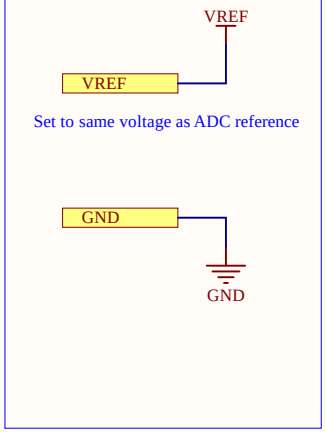

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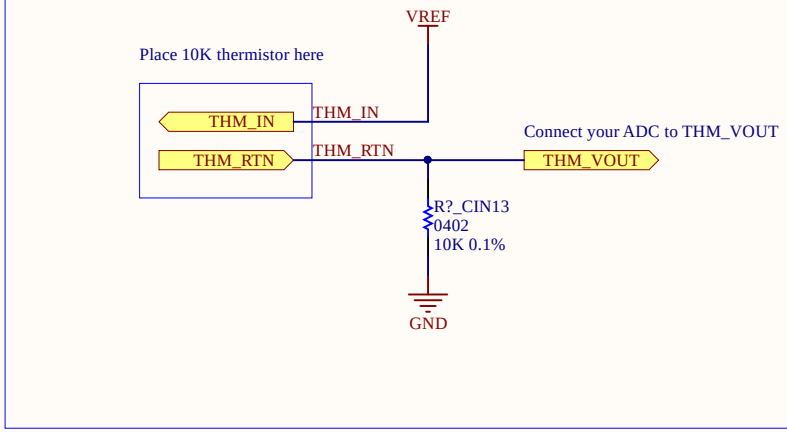

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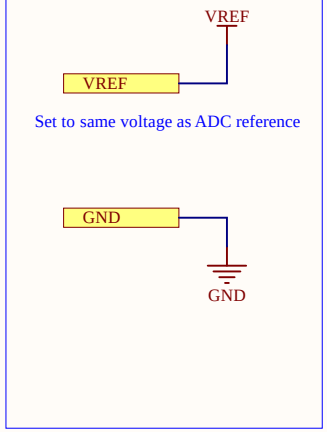

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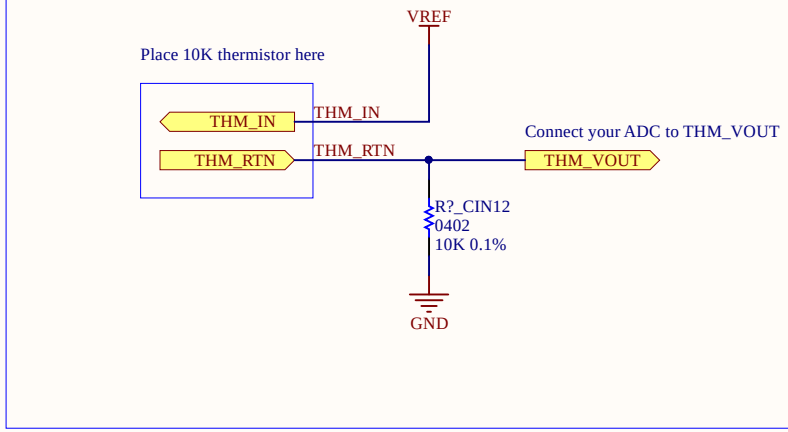

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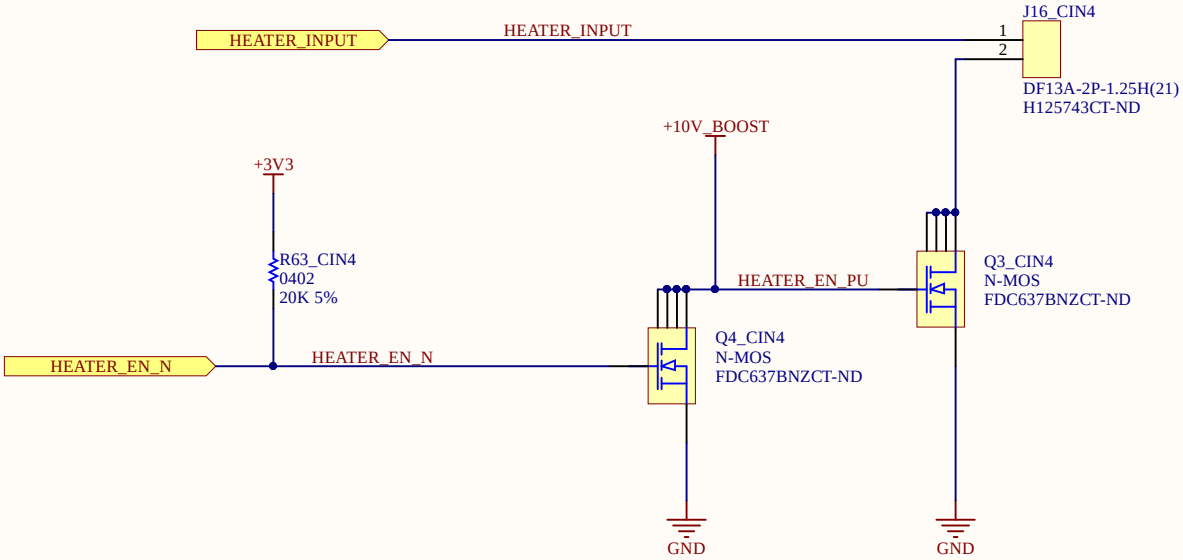

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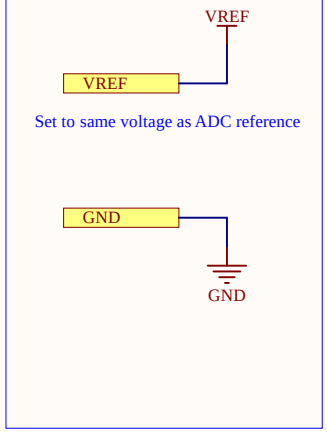

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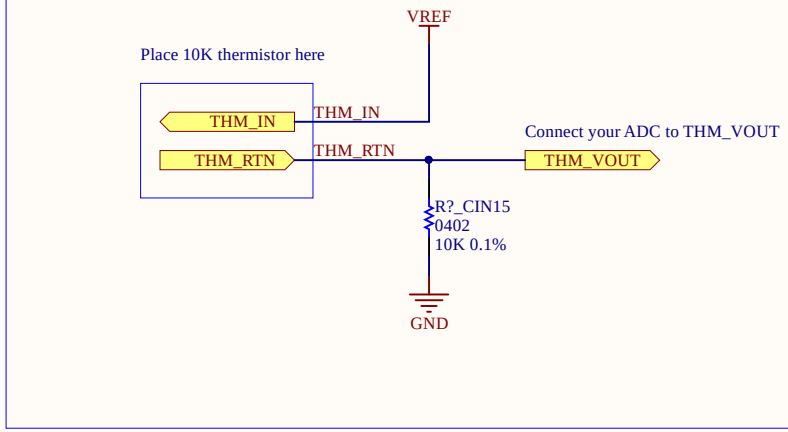

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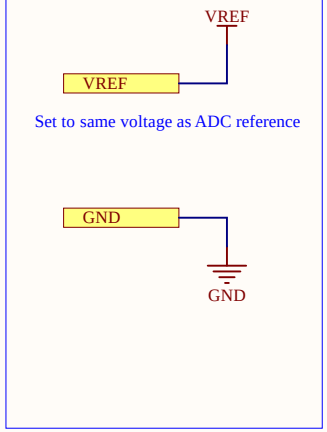
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



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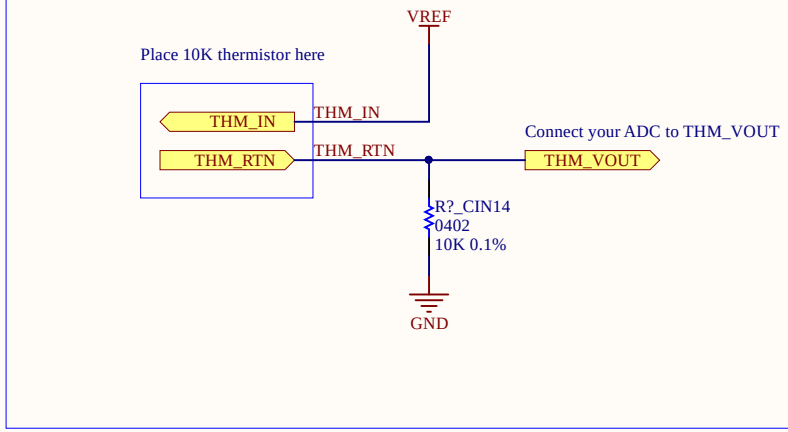

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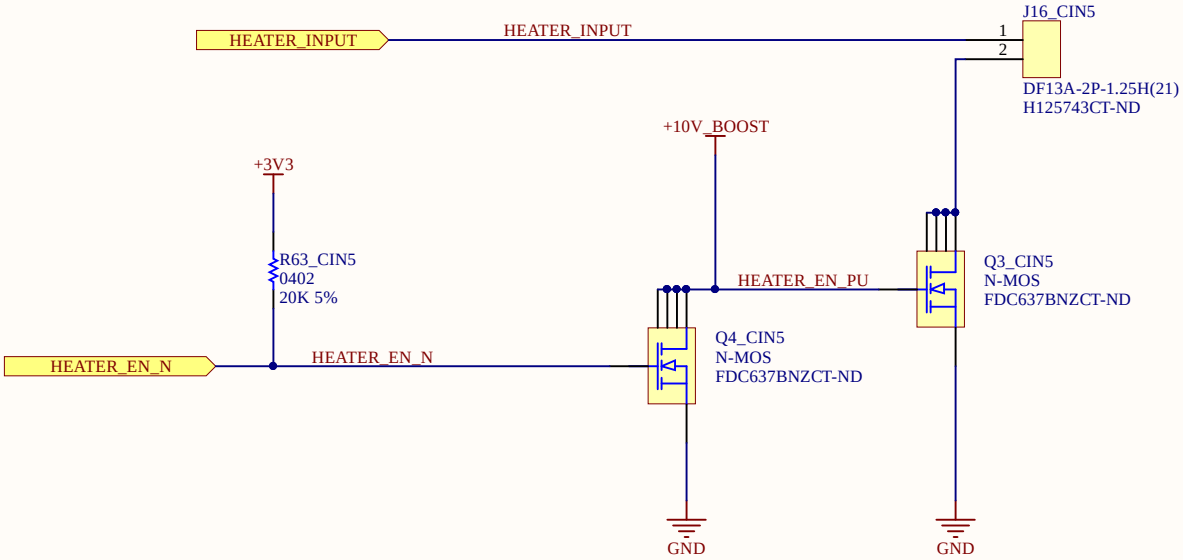

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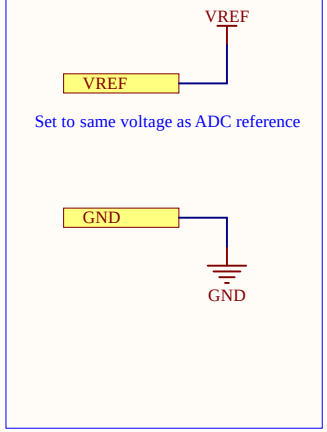

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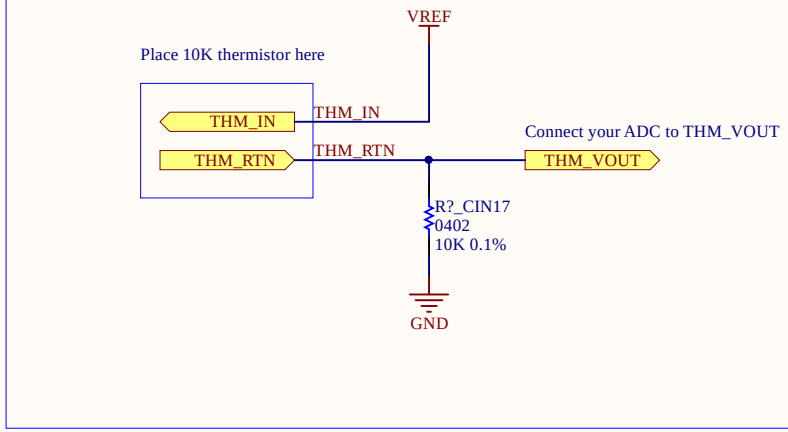

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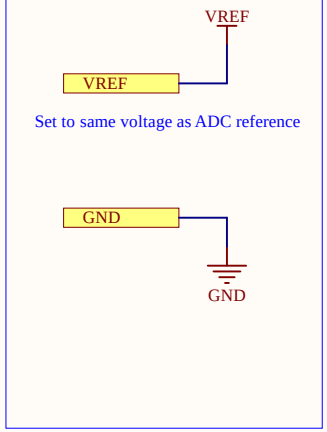
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



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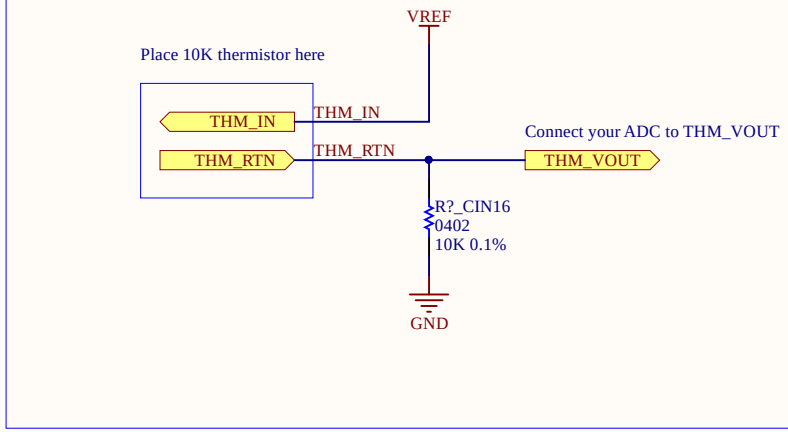

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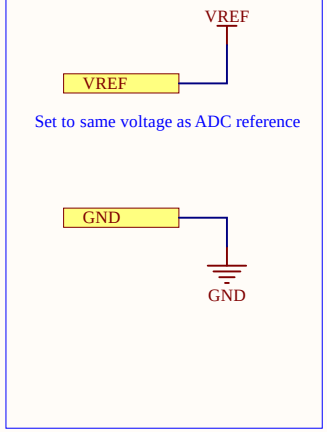
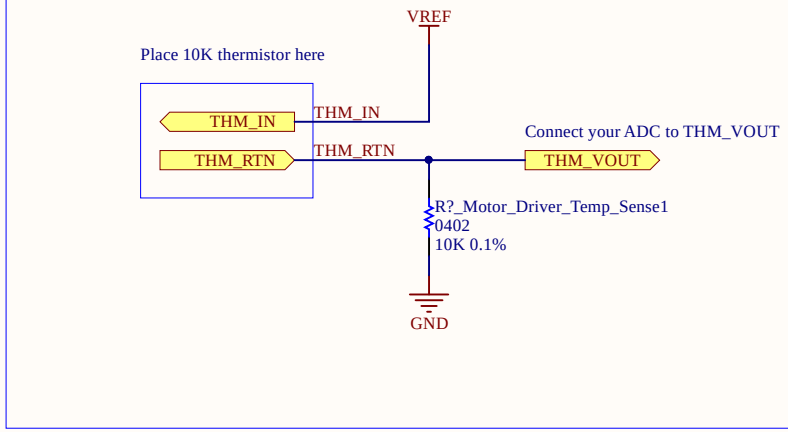
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS



THERMISTOR



Title	thermistor-input-10k.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.2
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS

AVCC >= VCC (pg 51)

VCC

VCC

1.7 to 5.25V input

AVCC

AVCC

2.7 to 5.25V input

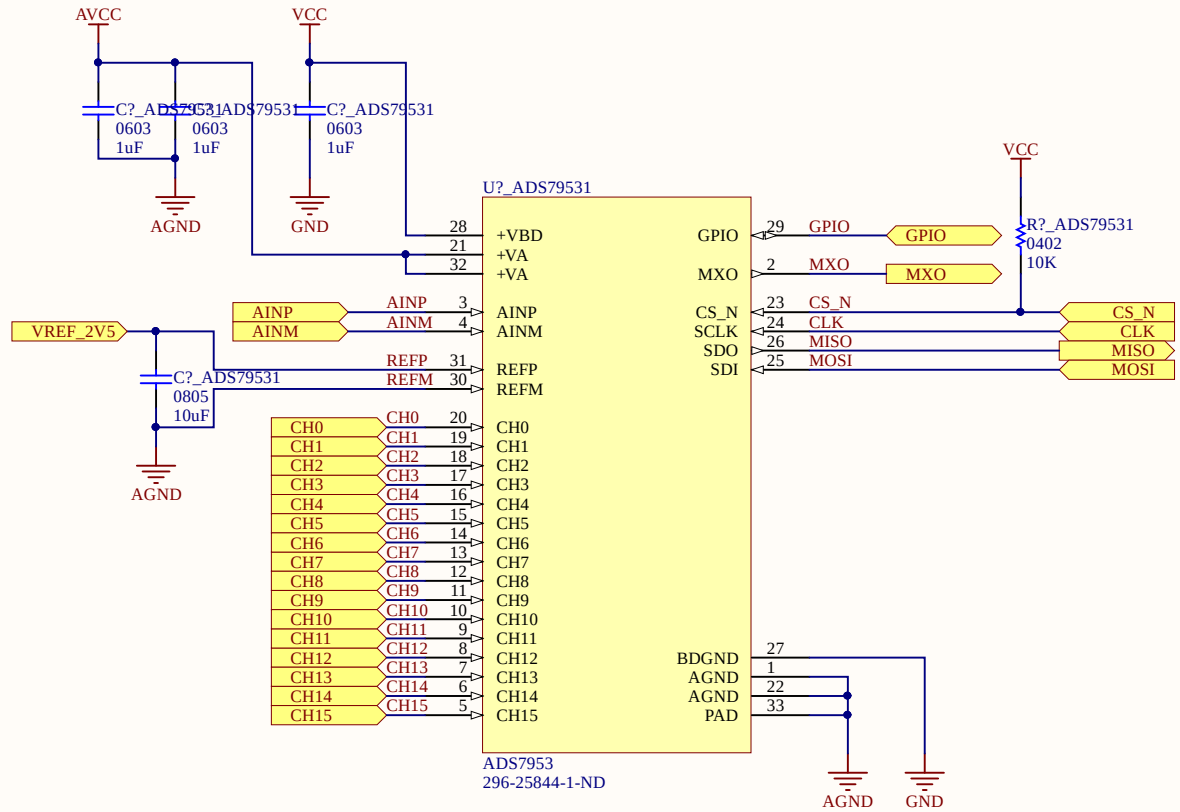
GND

GND

AGND

AGND

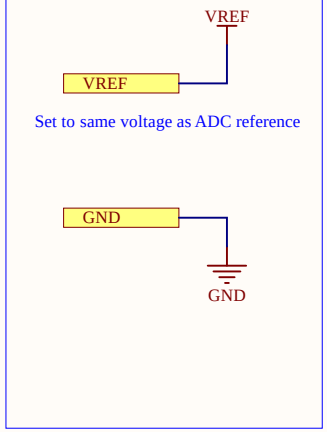
See pg 53, each +VA pin should have it's own 1uF



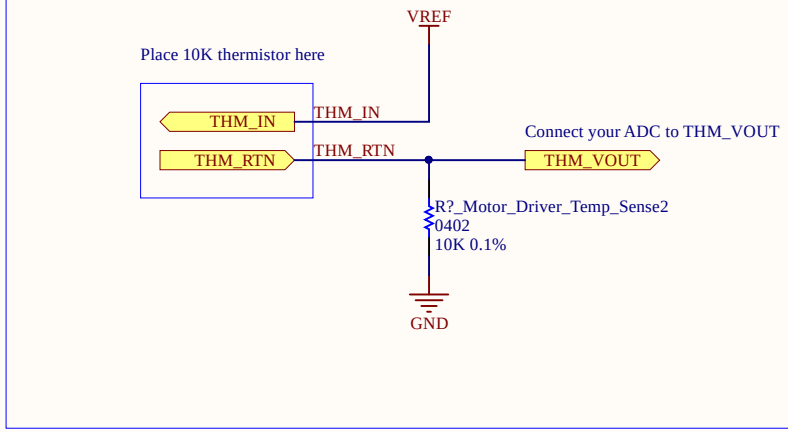
16 CHANNEL ADC

Title	adc-ADS7953.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\adc-ADS7953.SchDoc	Drawn By: Dylan Vogel	

POWER INPUTS



THERMISTOR



Title	thermistor-input-10k.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.2
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	

POWER INPUTS

AVCC >= VCC (pg 51)

VCC

1.7 to 5.25V input

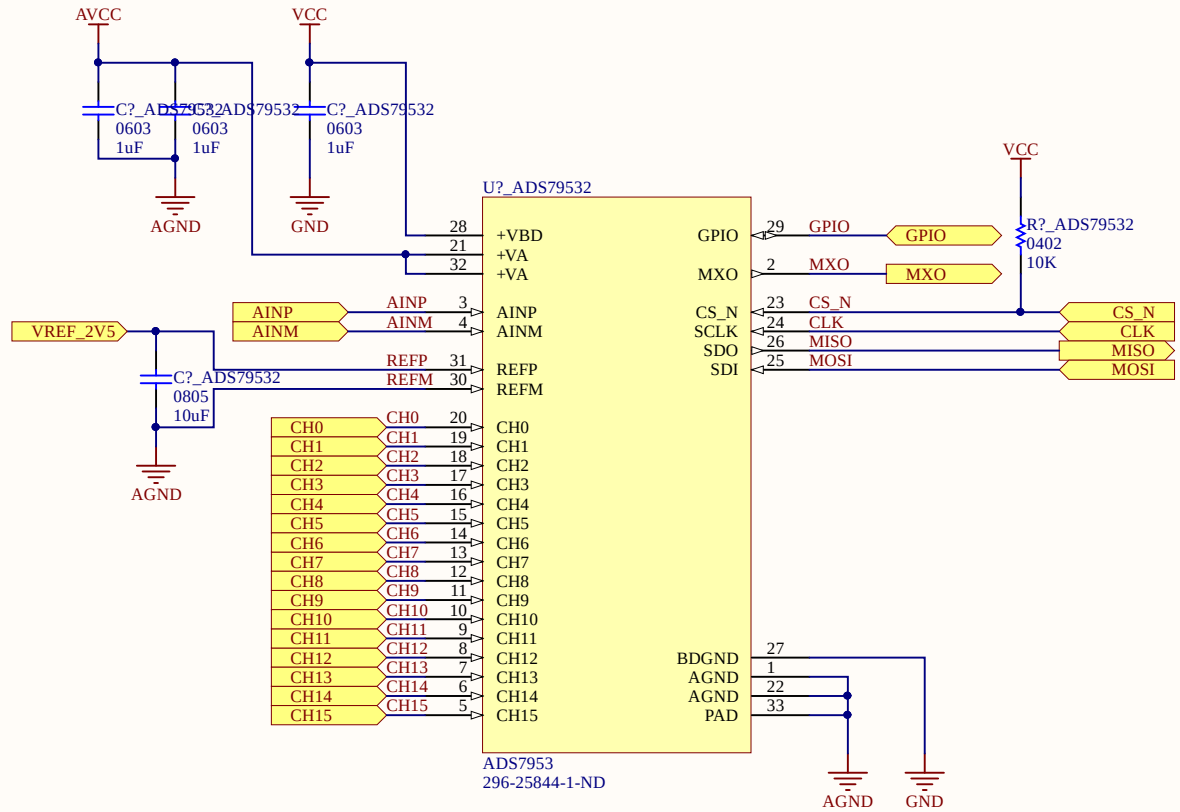
AVCC

2.7 to 5.25V input

GND

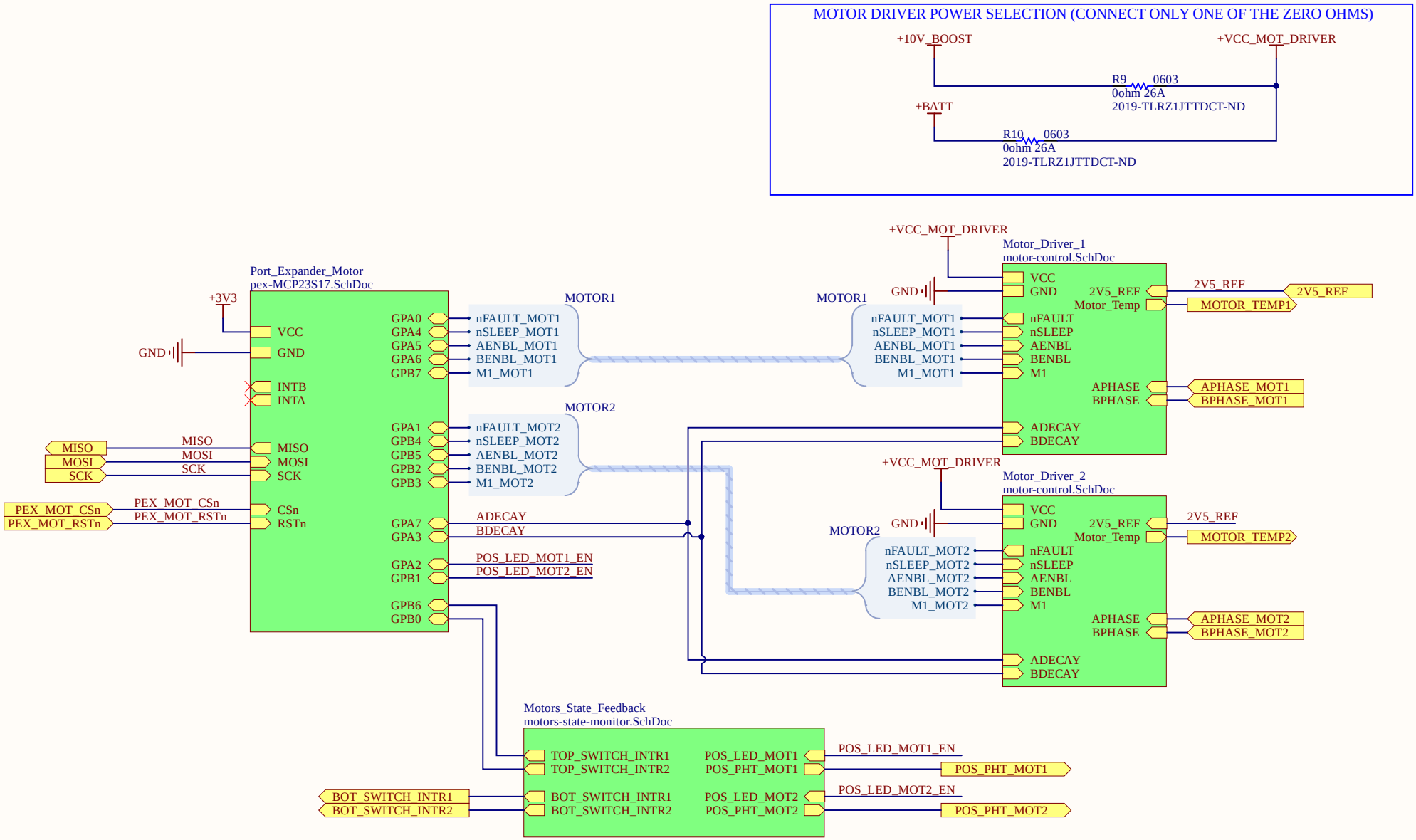
AGND

See pg 53, each +VA pin should have it's own 1uF

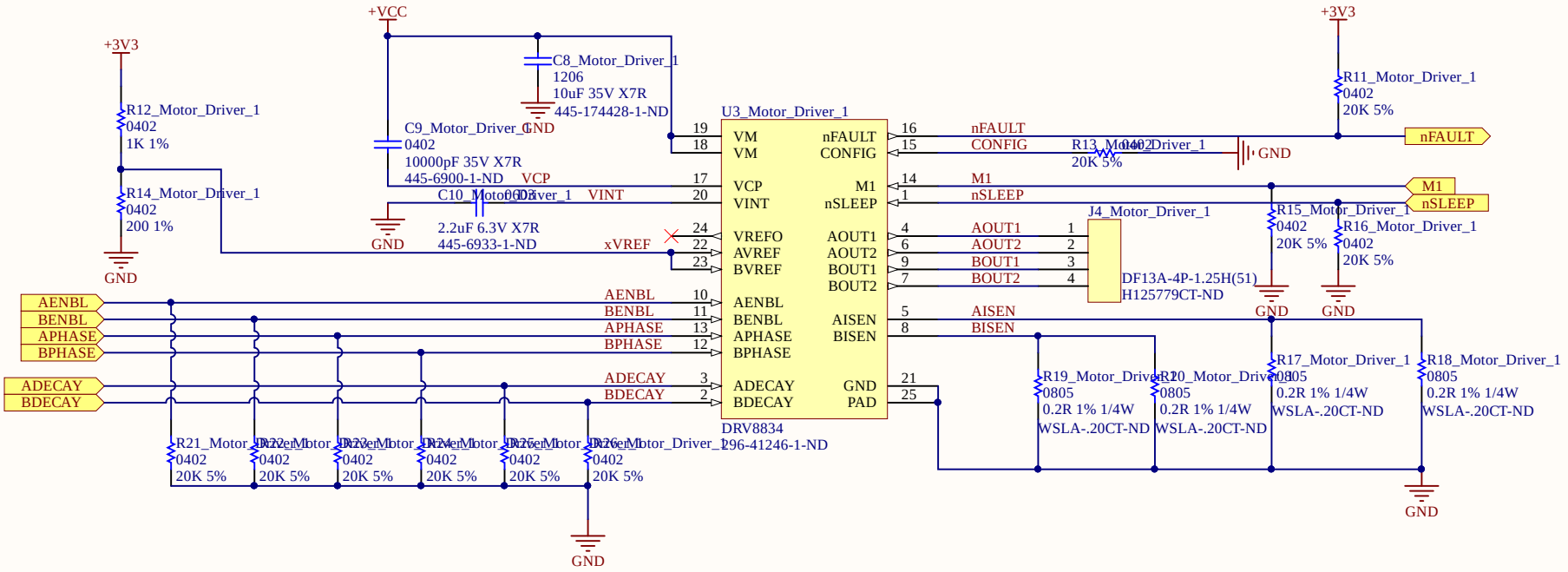


16 CHANNEL ADC

Title: adc-ADS7953.SchDoc		
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\adc-ADS7953.SchDoc	Drawn By: Dylan Vogel	



Title	motors-overview.SchDoc	pay-ssm.PrjPCB
Size: A4	Number:	Revision: v2
Date: 2019-07-24	Sheet 3 of 16	
File: C:\Users\..\motors-overview.SchDoc	Drawn By: Lorna Lan	



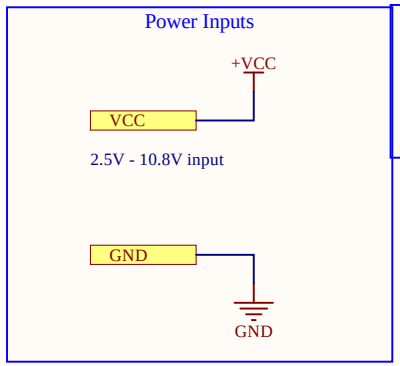
DRV8834 Motor Driver Notes

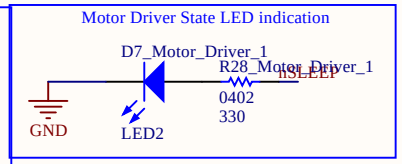
Datasheet: http://www.ti.com/lit/ds/symlink/drv8834.pdf

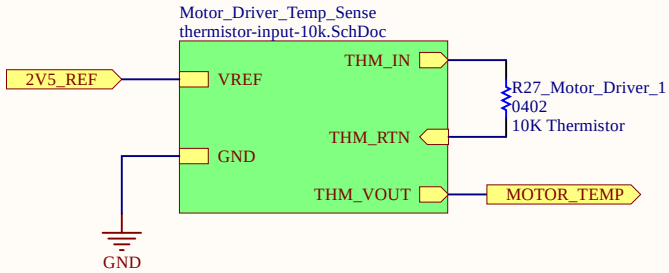
Indexer mode of this motor driver was tested to be not functioning, so everything is set in hardware to implement only the PHASE/ENABLE mode.

Implemented a voltage divider to set-up the xVREF voltage if want to modify xISEN and the resistor later. VREFO is left unconnected.

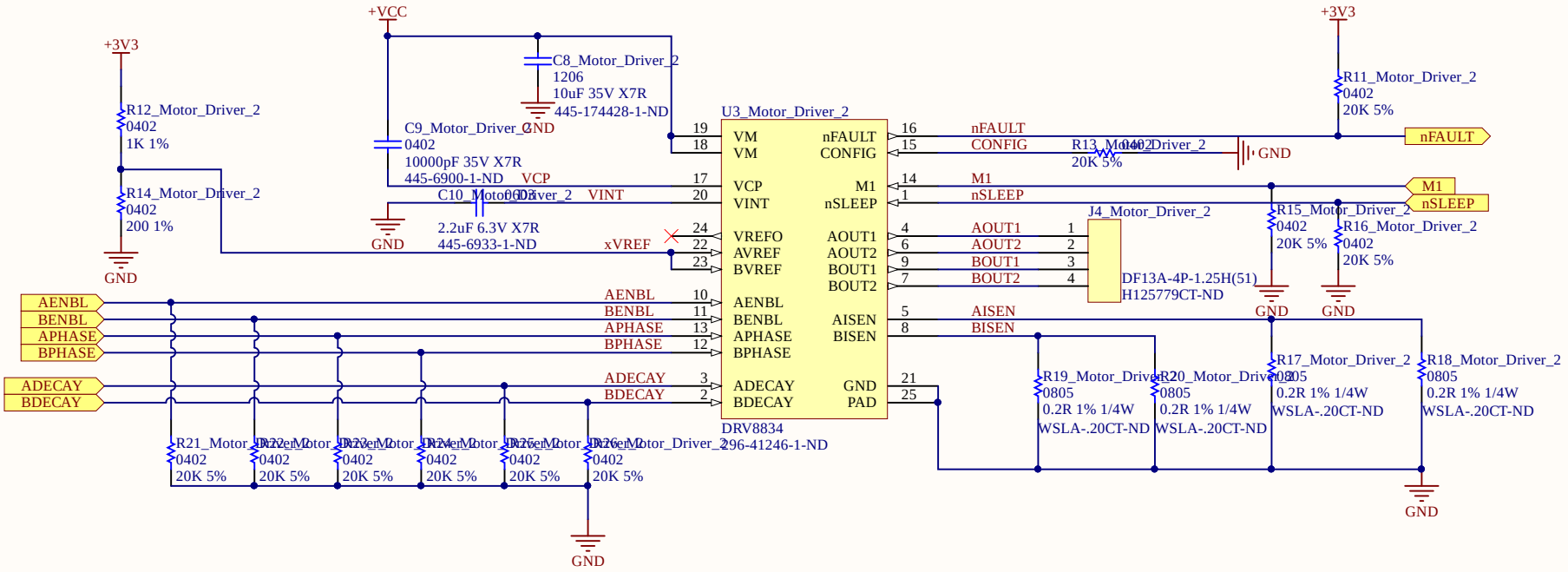
About decay settings: decay mode is selected by the voltage presented at the xDECAY pins in PHASE/ENABLE mode. It is also recommended with a pull-down to ground and a GPIO for setting.







Title	motor-control.SchDoc	pay-ssm.PrjPCB
Size: A4	Number:	Revision: v2
Date: 2019-07-24	Sheet 4 of 16	
File: C:\Users\..\motor-control.SchDoc	Drawn By: Lorna Lan, Dylan Vogel	



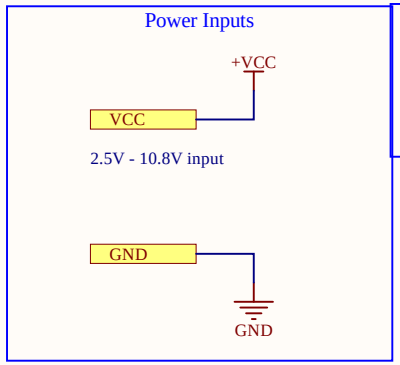
DRV8834 Motor Driver Notes

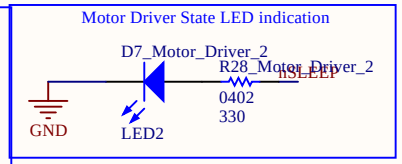
Datasheet: http://www.ti.com/lit/ds/symlink/drv8834.pdf

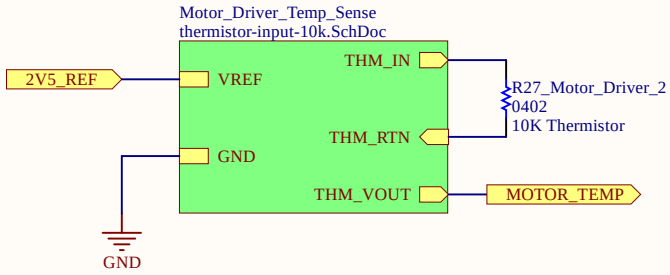
Indexer mode of this motor driver was tested to be not functioning, so everything is set in hardware to implement only the PHASE/ENABLE mode.

Implemented a voltage divider to set-up the xVREF voltage if want to modify xISEN and the resistor later. VREFO is left unconnected.

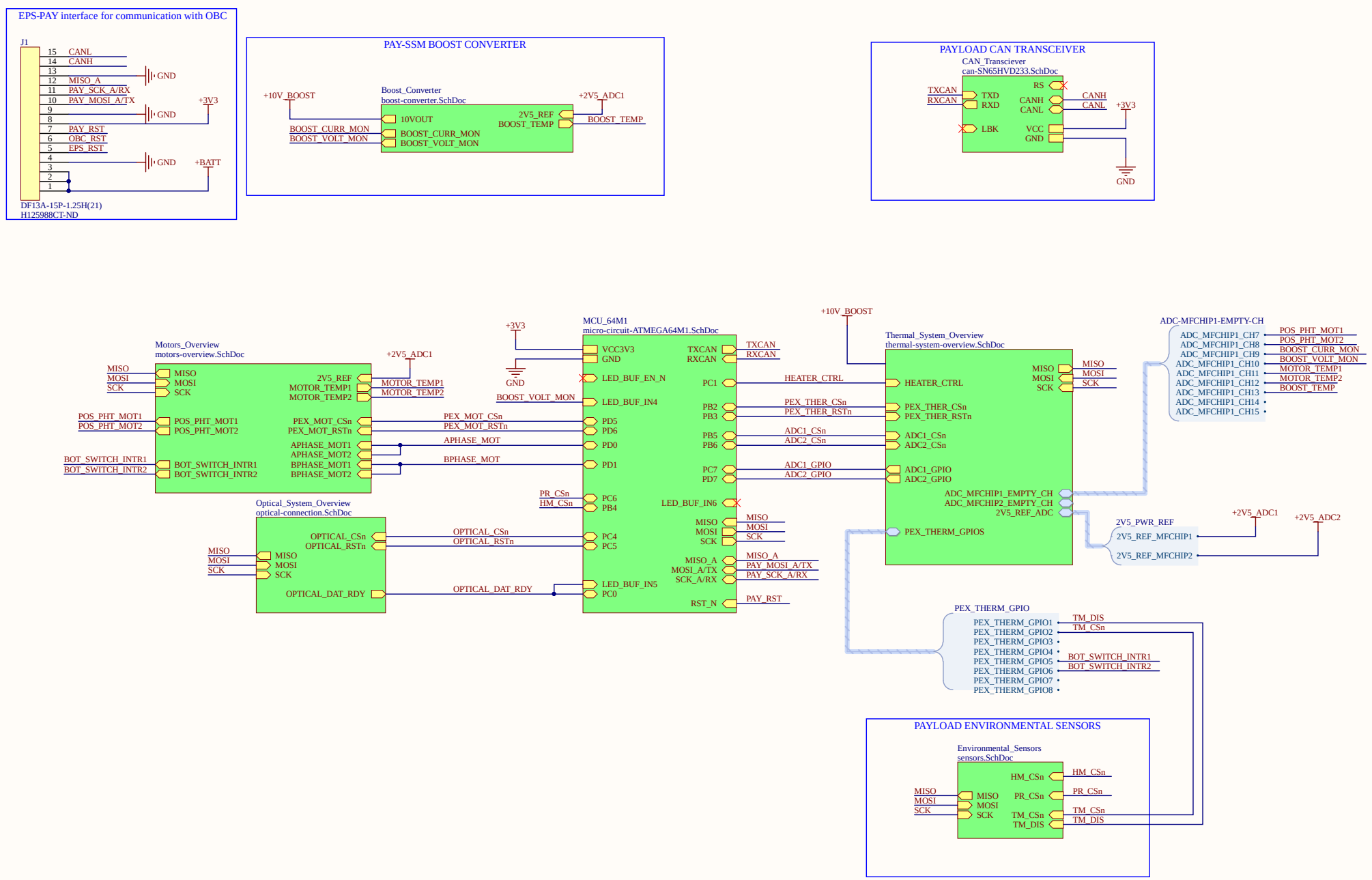
About decay settings: decay mode is selected by the voltage presented at the xDECAY pins in PHASE/ENABLE mode. It is also recommended with a pull-down to ground and a GPIO for setting.





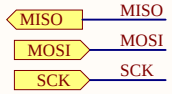


Title: motor-control.SchDoc		pay-ssm.PrjPCB
Size: A4	Number:	Revision: v2
Date: 2019-07-24		Sheet 4 of 16
File: C:\Users\..\motor-control.SchDoc		Drawn By: Lorna Lan, Dylan Vogel

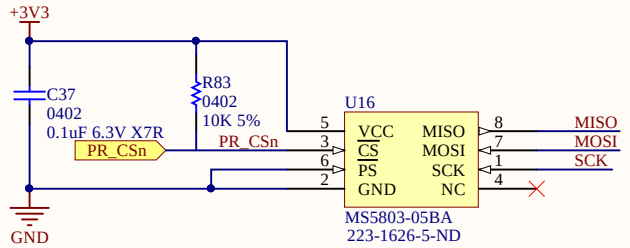


Title	pay-ssm.SchDoc	pay-ssm.PrjPCB
Size: A3	Number	Revision: v4.2
Date: 2019-07-24	Sheet 1 of 16	
File: C:\Users\..\pay-ssm.SchDoc	Drawn By: Lorna Lan	

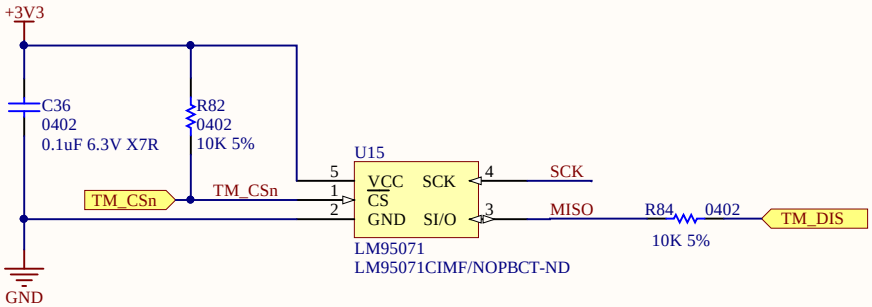
SENSOR SPI LINE



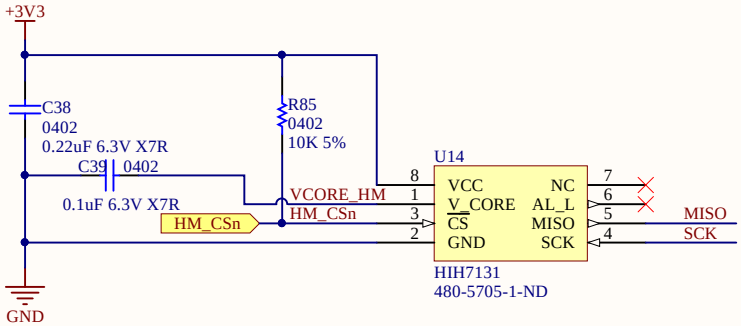
PRESSURE SENSOR



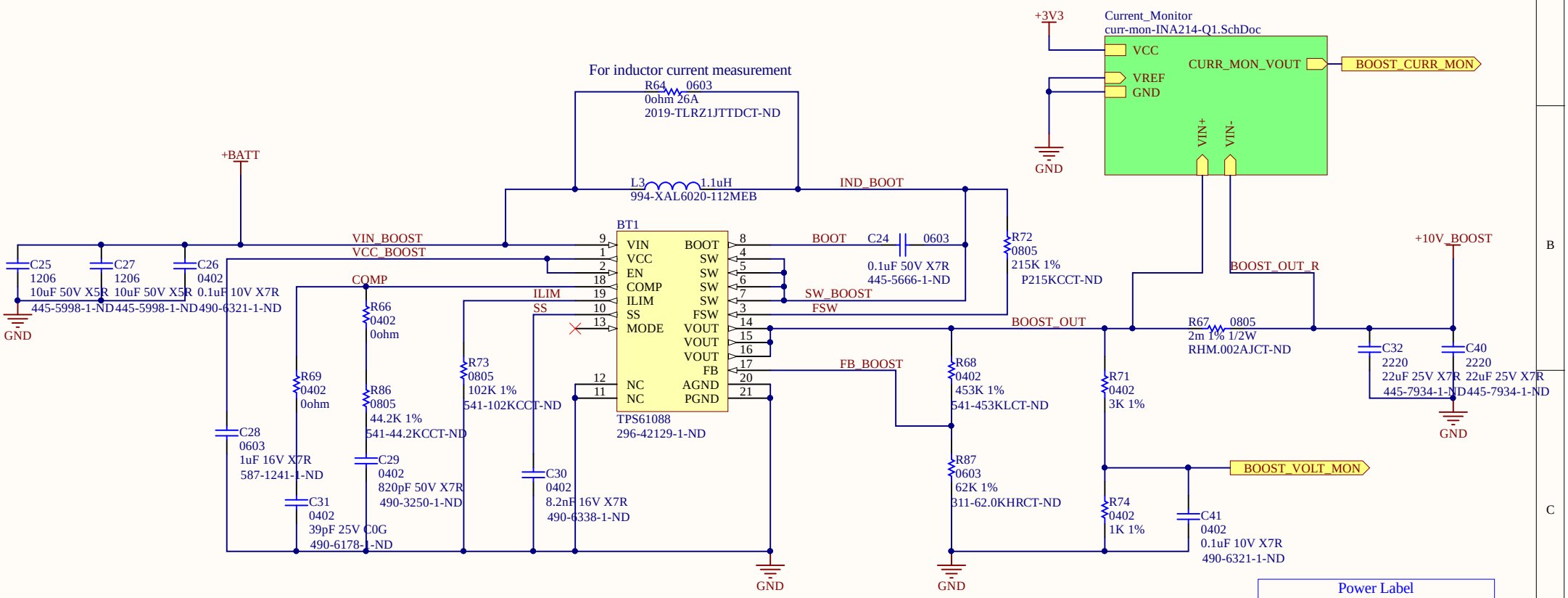
AMBIENT TEMPERATURE SENSOR



HUMIDITY SENSOR



Title: sensors.SchDoc		pay-ssm.PrjPCB
Size: A4	Number:	Revision: v2
Date: 2019-07-24		Sheet 16 of 16
File: C:\Users\..\sensors.SchDoc		Drawn By: Dylan Vogel, Lorna Lan



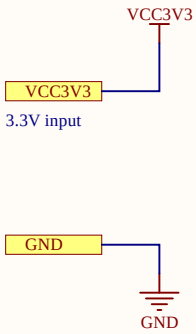
WEBENCH simulation link:

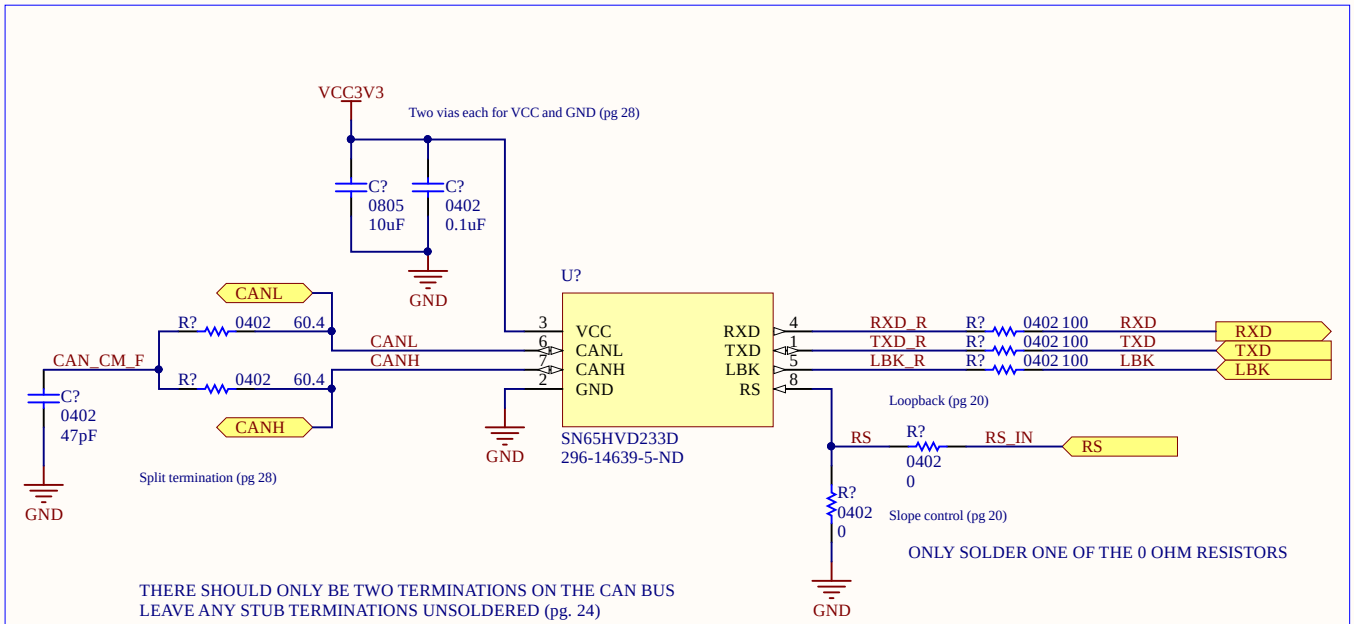
Parameters:
TPS61088RHLR 3.6V-4.2V to 10.00V @ 2.8A

https://webench.ti.com/appinfo/webench/scripts/SDP.cgi?ID=CCD7917ED8455F42

Title	boost-converter.SchDoc	pay-ssm.PrjPCB
Size: A4	Number:	Revision: *
Date: 2019-07-24		Sheet * of *
File: C:\Users\..\boost-converter.SchDoc		Drawn By: *

POWER INPUT





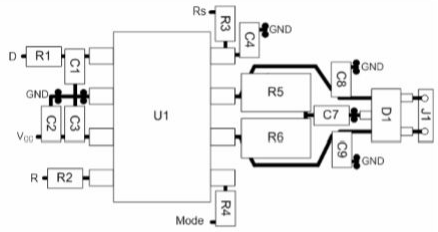


Figure 41. Layout Example Schematic

See pg. 28 of the datasheet for layout guidelines

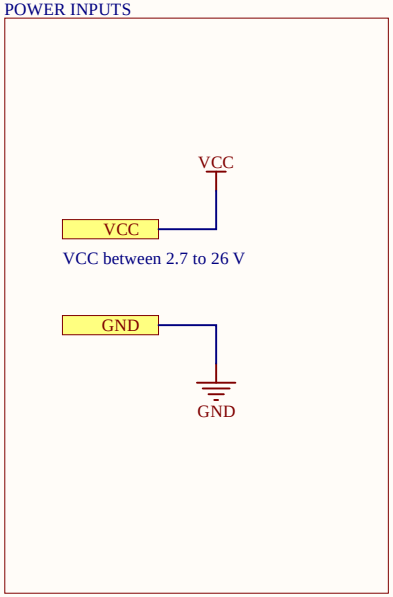
This schematic implements the SN65HVD233 CAN transciever with loopback control and two options for slope control.

A 0 Ohm resistor can be soldered to GND to permanently put the device in high speed mode (20 V / us slew), or a 0 Ohm resistor can be soldered to the RS port to control the device via an external microcontroller. Connecting the RS pin to a microcontroller allows the device to be put into low-power mode by setting the RS pin high.

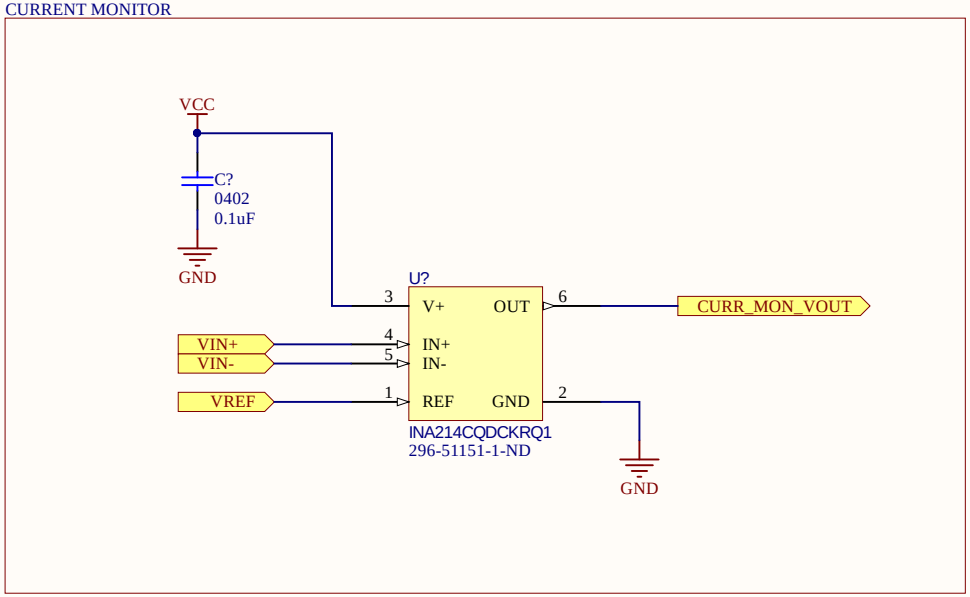
- Device is meant to be used in a 3.3 V system
- 100 Ohm current limiting resistors placed on the digital lines to minimize digital noise to the device
- Only two CAN transcievers on the bus should have 120 ohm terminations. Other devices should be placed on 'stub' networks where the terminations are left unsoldered

Title	can-SN65HVD233.SchDoc		
Size	A4	Number	PCBS-COMMON
Revision	1.2		
Date:	2019-07-24	Sheet * of *	
File:	C:\Users\..\can-SN65HVD233.SchDoc	Drawn By:	Dylan Vogel

POWER INPUTS



CURRENT MONITOR



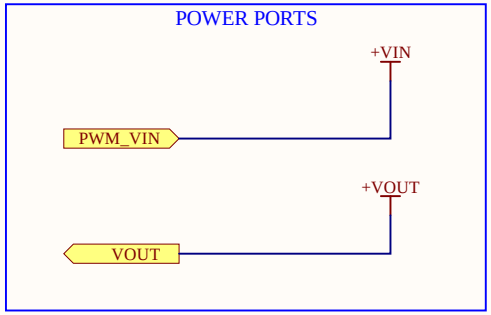
This schematic implements the INA214-Q1 automotive grade, voltage output, high- or low-side, bidirectional, zero-drift current shunt monitor

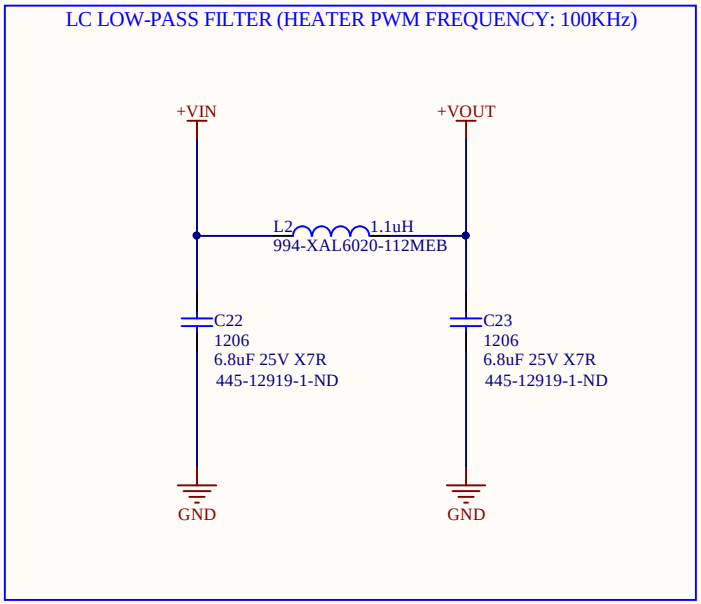
Application Information:

- This amplifier has an internal gain of 100x
- Place a small value current sense resistor (1 -> 10 mOhm) in series with the current you're trying to monitor. Connect VIN+ of the current monitor to the positive terminal of the resistor, and VIN- to the negative terminal.
- Assume the worst-case input voltage offset is 100uV. This allows you to calculate your expected measurement error. No strict guideline on what this should be, but if your full-scale current generates a voltage of 10mV across your sen resistor, that's 1% error. Typical error will be lower than this.

- For unidirectional operation (current in one direction) connect VREF to GND
- For bidirectional operation, UTAT reccommends connecting VREF to the stable 2.5V reference you probably already use for your ADC. Pop a 0.1uF on your VREF connection in that case.
- To calculate your current range for bidirectional, understand that forward current will cause VOUT to rise from 2.5 V up to VCC - 0.2 V. Reverse current will cause VOUT to drop from 2.5V to GND. Divide this voltage swing in each direction by (100 * R_sense) to figure out your max current

Title	curr-mon-INA214-Q1.SchDoc		
Size	Number		Revision
A4	PCBS-COMMON		1.0
Date:	2019-07-24	Sheet *	of *
File:	C:\Users\..\curr-mon-INA214-Q1.SchDoc	Drawn By:	J. Reimer, D. Vogel



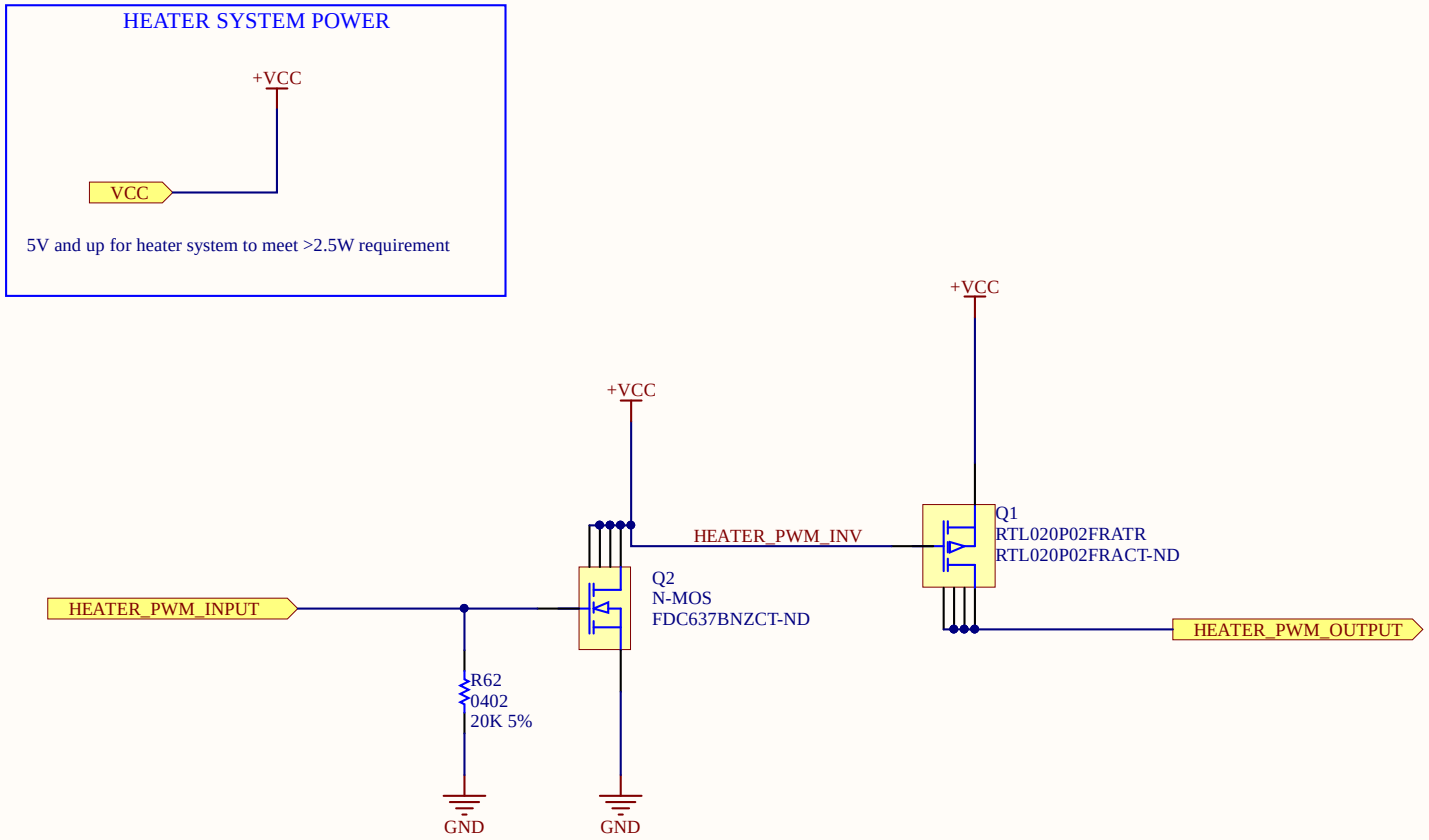


Here we want the cut-off frequency Fc to be < 100KHz to smooth out the output current to the heaters.

Fc = 1/pi*sqrt(LC) in this pi configuration. In this case Fc is calculated to be 1/pi*sqrt(4.7*2.2*2*10^-12) = 69.996KHz. Should safely filter out the PWM frequency of 100KHz.

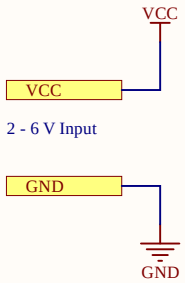
If change to 1.1uF inductor as the boost converter, can switch the C22/C23 to 6.8.uF 35V. The new cut-off frequency is 1/pi*sqrt(1.1*6.8*2*10^-12) = 82.297 KHz.

Title		
Size: A4	Number	Revision
Date: 2019-07-24		Sheet of
File: C:\Users\..\heater-LC-filtering.SchDoc		Drawn By:

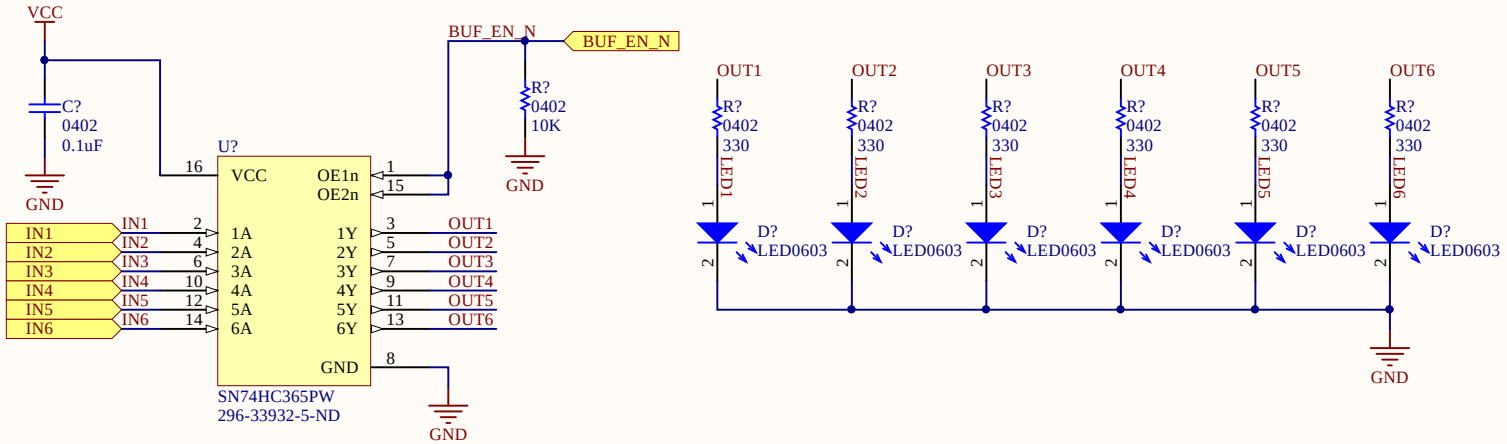


Title			
Size A	Number		Revision
Date:	2019-07-24	Sheet	of
File:	C:\Users\..\heater-pwm-logic.SchDoc	Drawn By:	

INPUT POWER



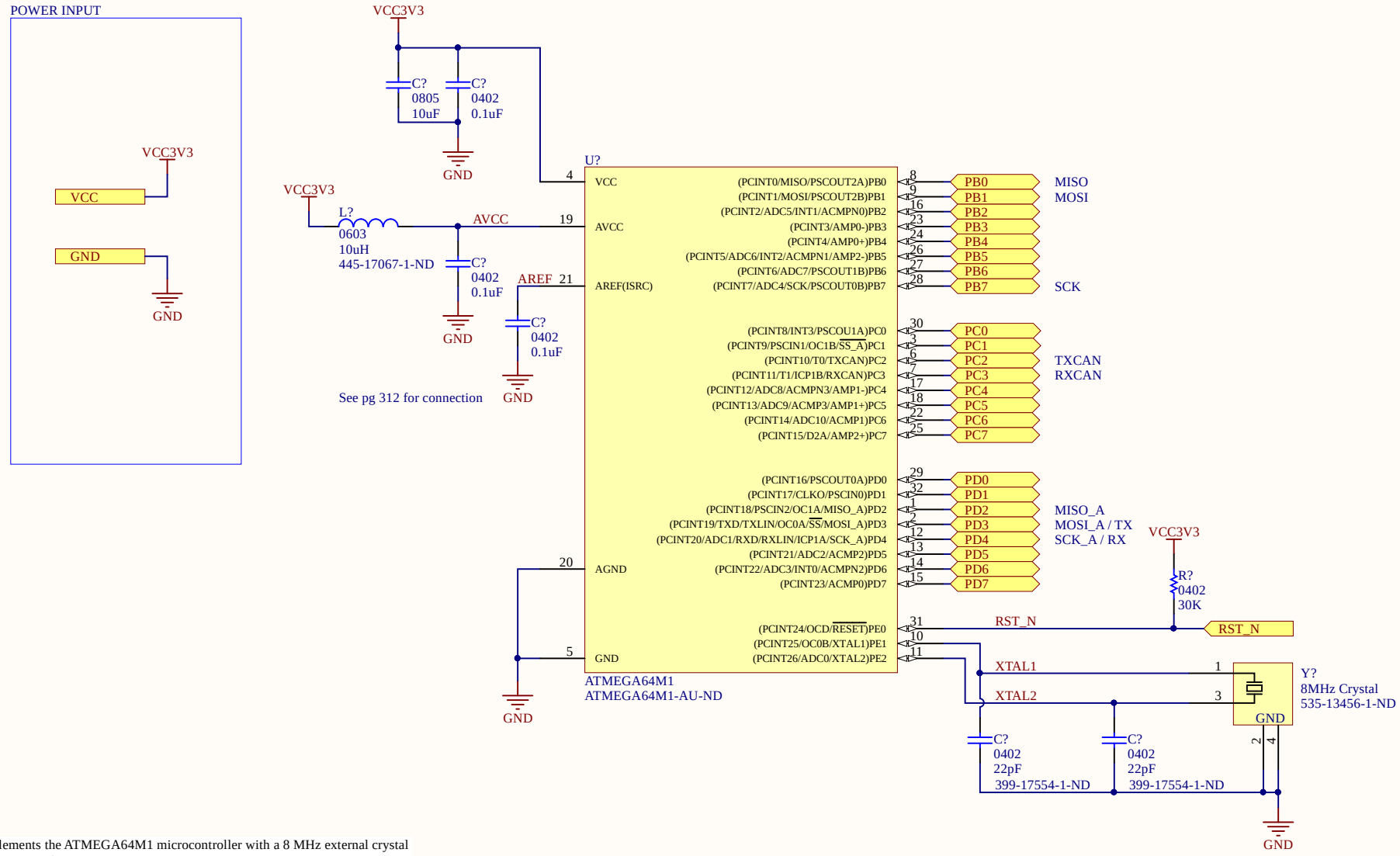
LED BUFFER



This schematic implements the SN74HC365PW non-inverting, tri-state hex buffer as an LED monitoring circuit. Connecting a signal to IN[1:6] will light up the corresponding LED on OUT[1:6].

- The BUF_EN_N input can be connected to a mircocontroller to control the buffer. An input HIGH will set the outputs to high-impedance and disable the LEDs.
- In the schematic symbol which references this schematic sheet, parameters LED[1:6] can be added to specify the colour of each LED. See the micro-circuit common sheet for an example of this.
- Unconnected inputs should be grounded if you don't want random flickering of the LEDs.

Title	led-monitoring-SN74HC365PW.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\led-monitoring-SN74HC365PW.SchDoc	Drawn By: Dylan Vogel	

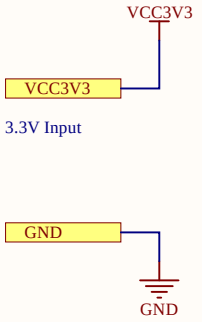


This schematic implements the ATMEGA64M1 microcontroller with a 8 MHz external crystal and necessary power connections.

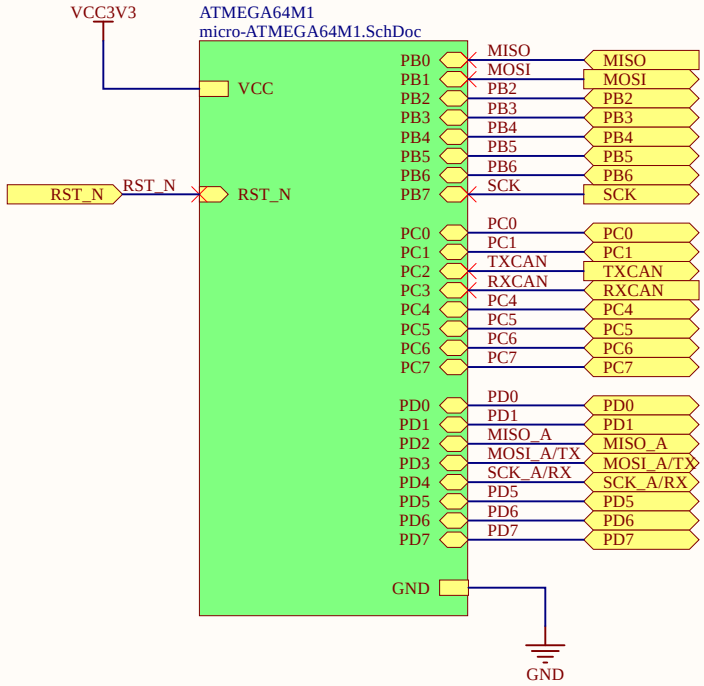
- Crystal is connected in a Pierce configuration, values of the capacitors were calculated based on the capacitance of the crystal and ESR.
- I would read through 18.5.2 and 18.6.2 of the complete 64M1 datasheet if you're interested in the motivation behind the ADC input connections. They recommend connecting AVCC through a RC lowpass network to minimize noise.
- If the ADC functionality of the device is used, either AVCC or the internal 2.56 V source can be seleted in software as the reference voltage.

Title	micro-ATMEGA64M1.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\micro-ATMEGA64M1.SchDoc	Drawn By: Dylan Vogel	

POWER INPUTS

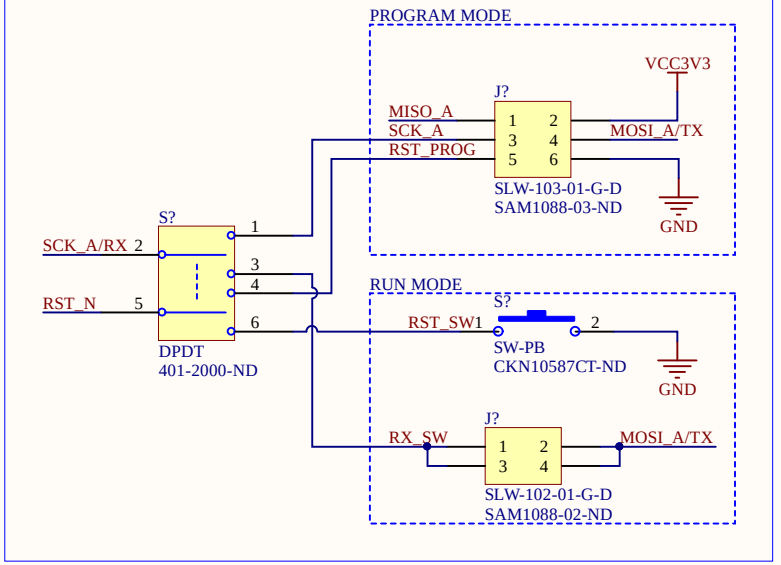


ATMEGA32M1

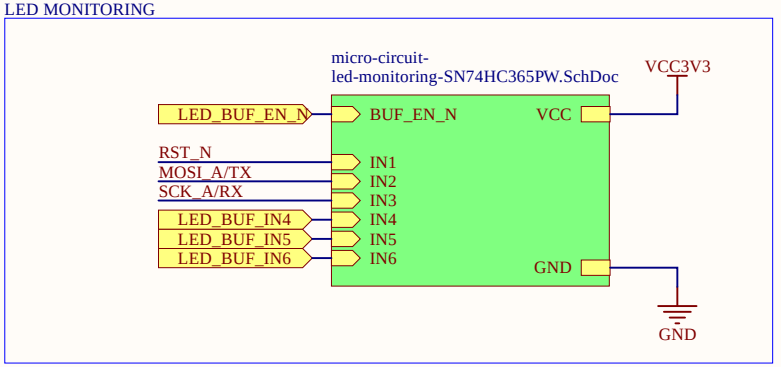


Specific No-ERCs placed for I/O Port and Bidirectional Sheet Entry

MODE SELECT CIRCUITRY



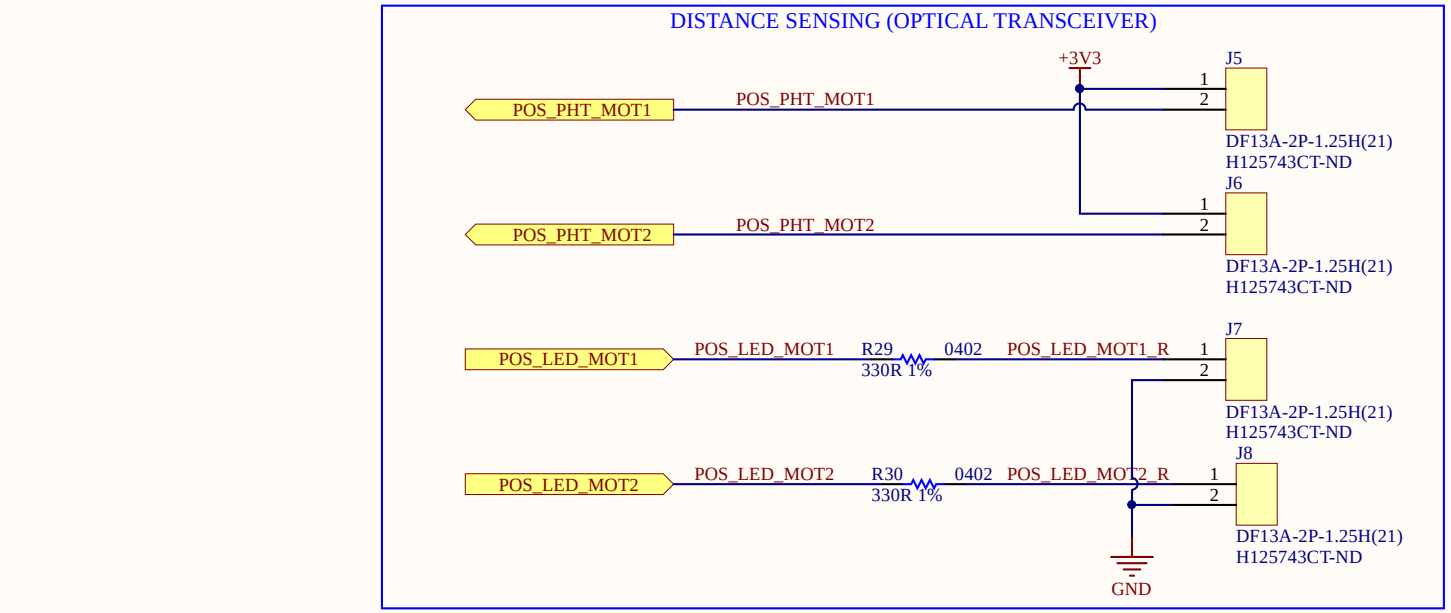
LED MONITORING

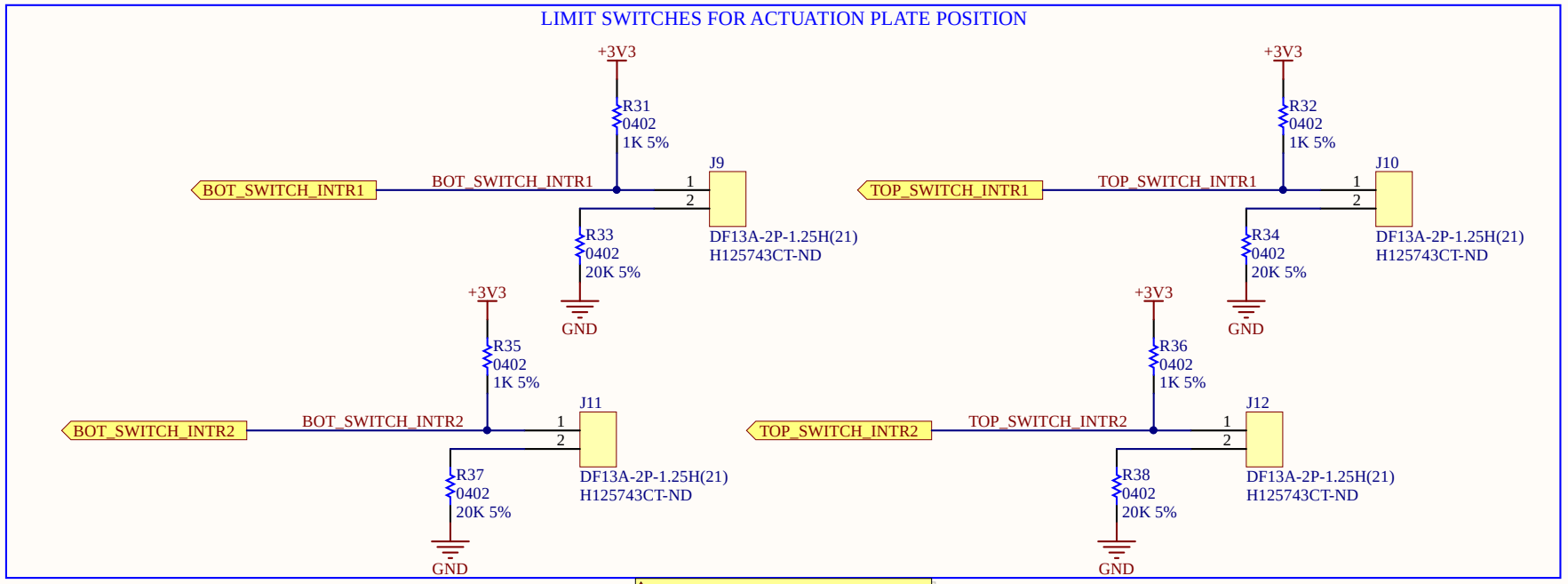


This schematic extends the functionality already included in the micro-ATMEGA32M1 schematc, adding a mode select switch, programming header, reset button and LED indication for TX, RX and RSTn.

- IN[4:6] of the LED buffer have been left unconnected, but are broken out on ports LED_BUF_IN[4:6]. They can be connected in the schematic which includes this sheet to monitor up to an additional 3 lines. Highly recommend more blinking lights.

Title	micro-circuit-ATMEGA64M1.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet *	of *
File: C:\Users\..\micro-circuit-ATMEGA64M1.SchDoc	Drawn By:	Dylan Vogel

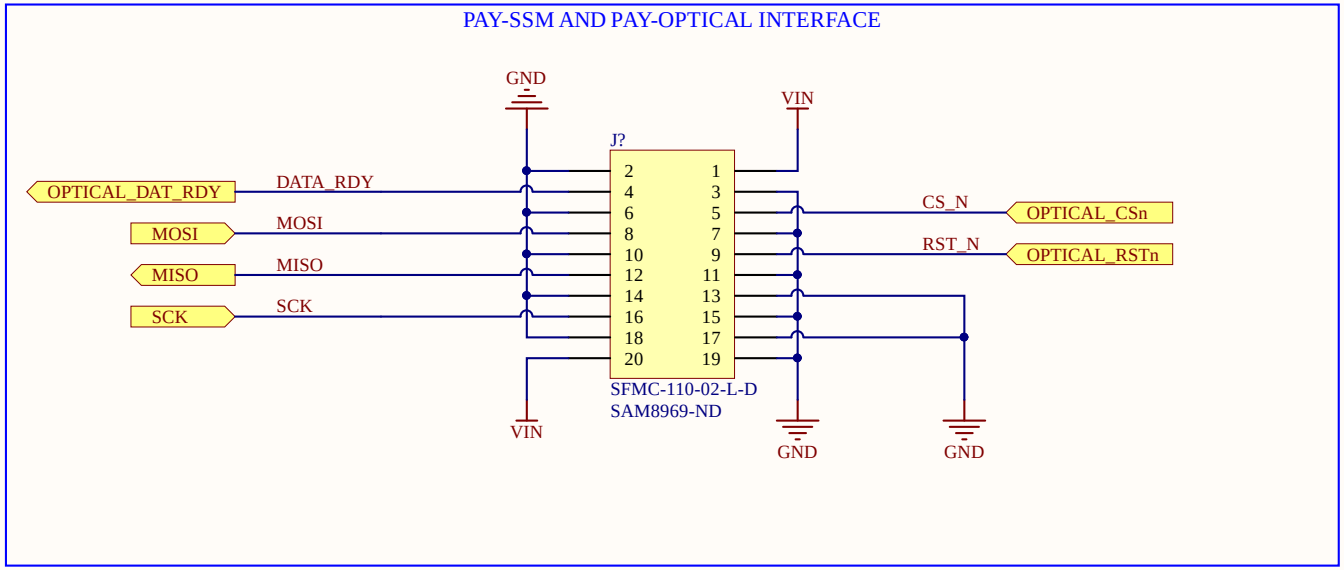




Assume the switch is normally opened, then closes when made contact, creating a logic HIGH signal

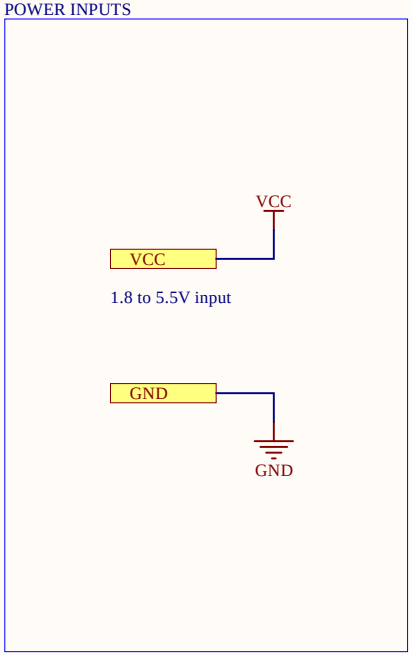
Switch product page: https://www3.panasonic.biz/ac/e/dl/catalog/index.jsp?series_cd=3066

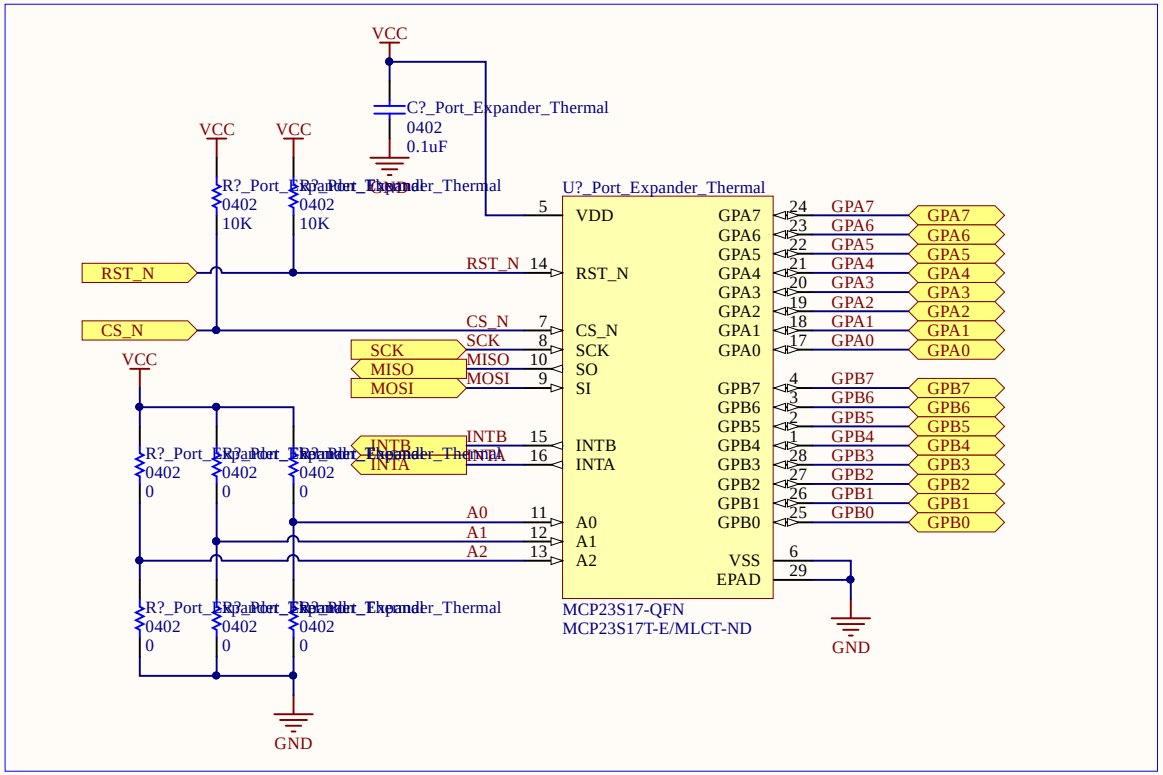
Title		
Size: A	Number	Revision
Date: 2019-07-24		Sheet of
File: C:\Users\..\motors-state-monitor.SchDoc		Drawn By:



Title	optical-connection.SchDoc		pay-ssm.PrjPCB
Size: A	Number:		Revision: v1.1
Date: 2019-07-24		Sheet * of *	
File: C:\Users\..\optical-connection.SchDoc		Drawn By: Dylan Vogel, Lorna Lan	

POWER INPUTS





ADDRESS:

CHANNEL SELECTION

ONLY SOLDER ONE 0 OHM FROM EACH PAIR
PEX ADDRESS = A2 A1 A0
VCC == 1 GND == 0

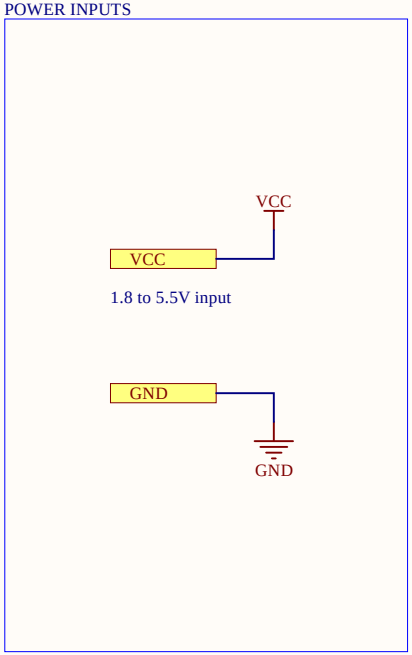
This schematic implements the MCP23S17 SPI port expander, and does some common-sense things like adding a bypass capacitor to the power supply and pull-up resistors to RST_N and CS_N.

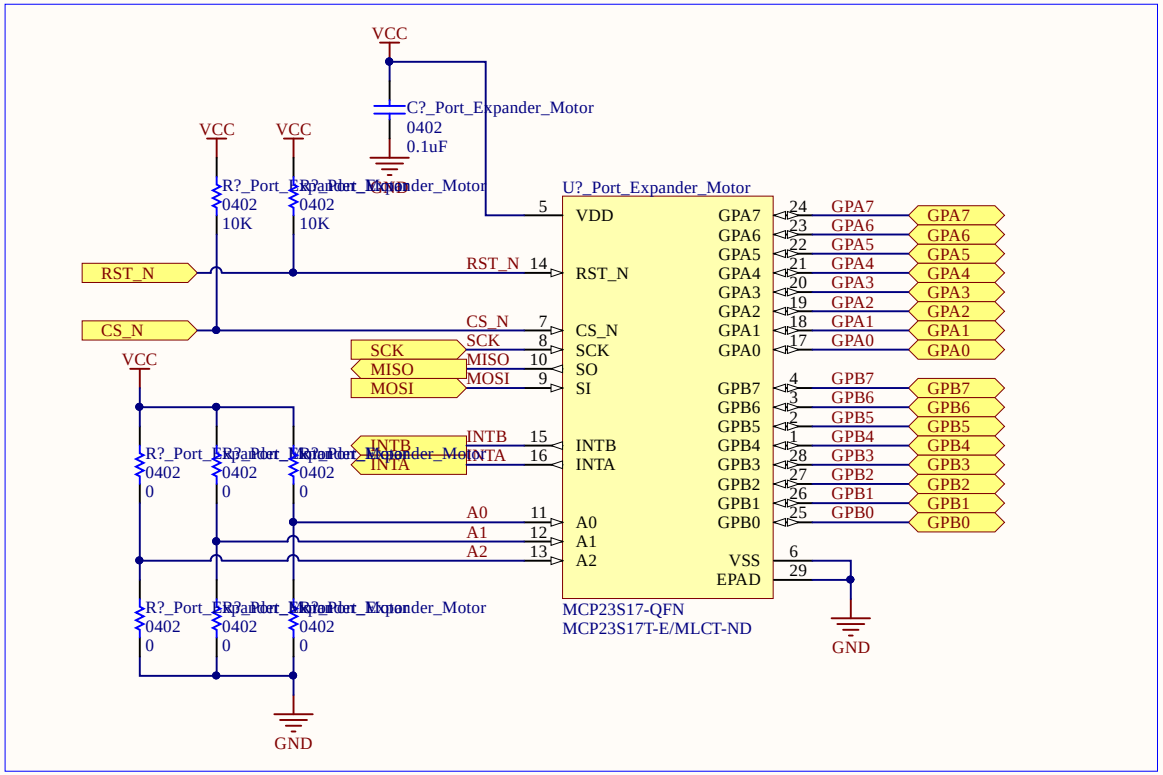
Multiple port expanders can be connected to the same CS_N line, and accessed via a device address that is used during software communication. This address is set in hardware via the A2, A1 and A0 pins. Soldering a 0 ohm resistor to VCC will set that bit to 1, and soldering to GND will set that bit to 0.

In the schematic which includes this file, you should make some note of the relevant hardware address that should be soldered during manufacturing.

Title	pex-MCP23S17.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\pex-MCP23S17.SchDoc	Drawn By: Dylan Vogel	

POWER INPUTS





ADDRESS:

CHANNEL SELECTION

ONLY SOLDER ONE 0 OHM FROM EACH PAIR
PEX ADDRESS = A2 A1 A0
VCC == 1 GND == 0

This schematic implements the MCP23S17 SPI port expander, and does some common-sense things like adding a bypass capacitor to the power supply and pull-up resistors to RST_N and CS_N.

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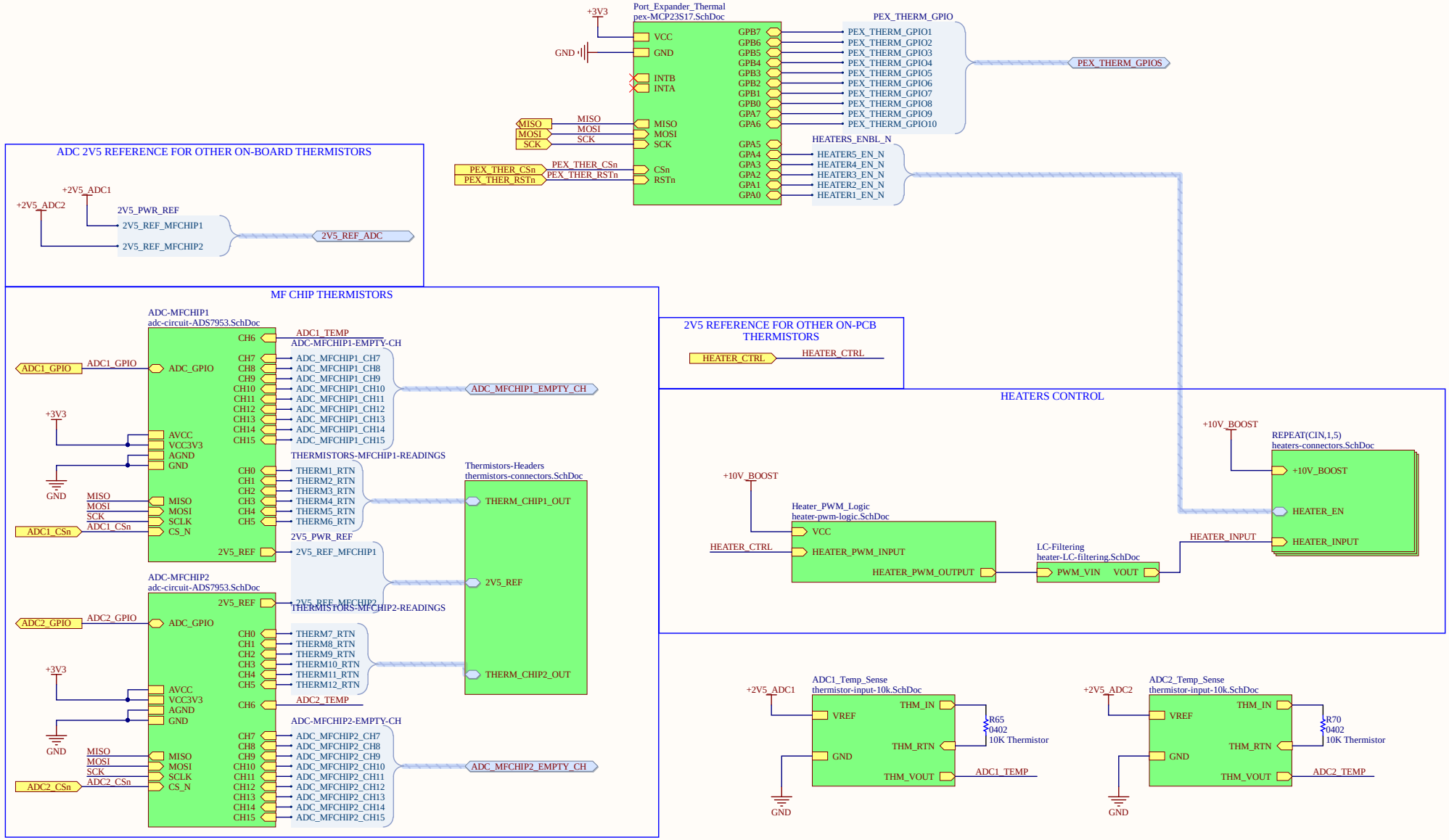
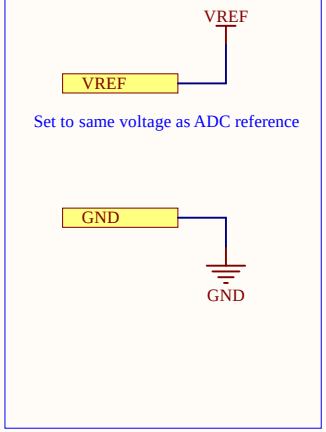
In the schematic which includes this file, you should make some note of the relevant hardware address that should be soldered during manufacturing.

Title	pex-MCP23S17.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\pex-MCP23S17.SchDoc	Drawn By: Dylan Vogel	

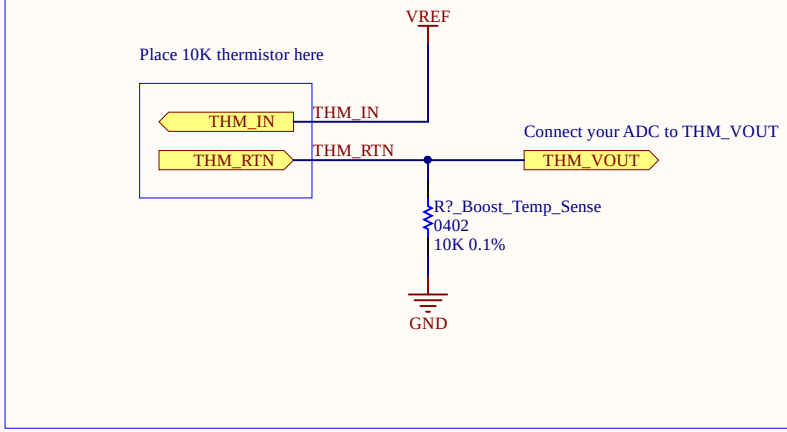


Title	thermal-system-overview.SchDoc	pay-ssm.PrjPCB
Size: A3	Number	Revision: v1
Date: 2019-07-24	Sheet * of *	
File: C:\Users\...\thermal-system-overview.SchDoc	Drawn By: Lorna Lan	

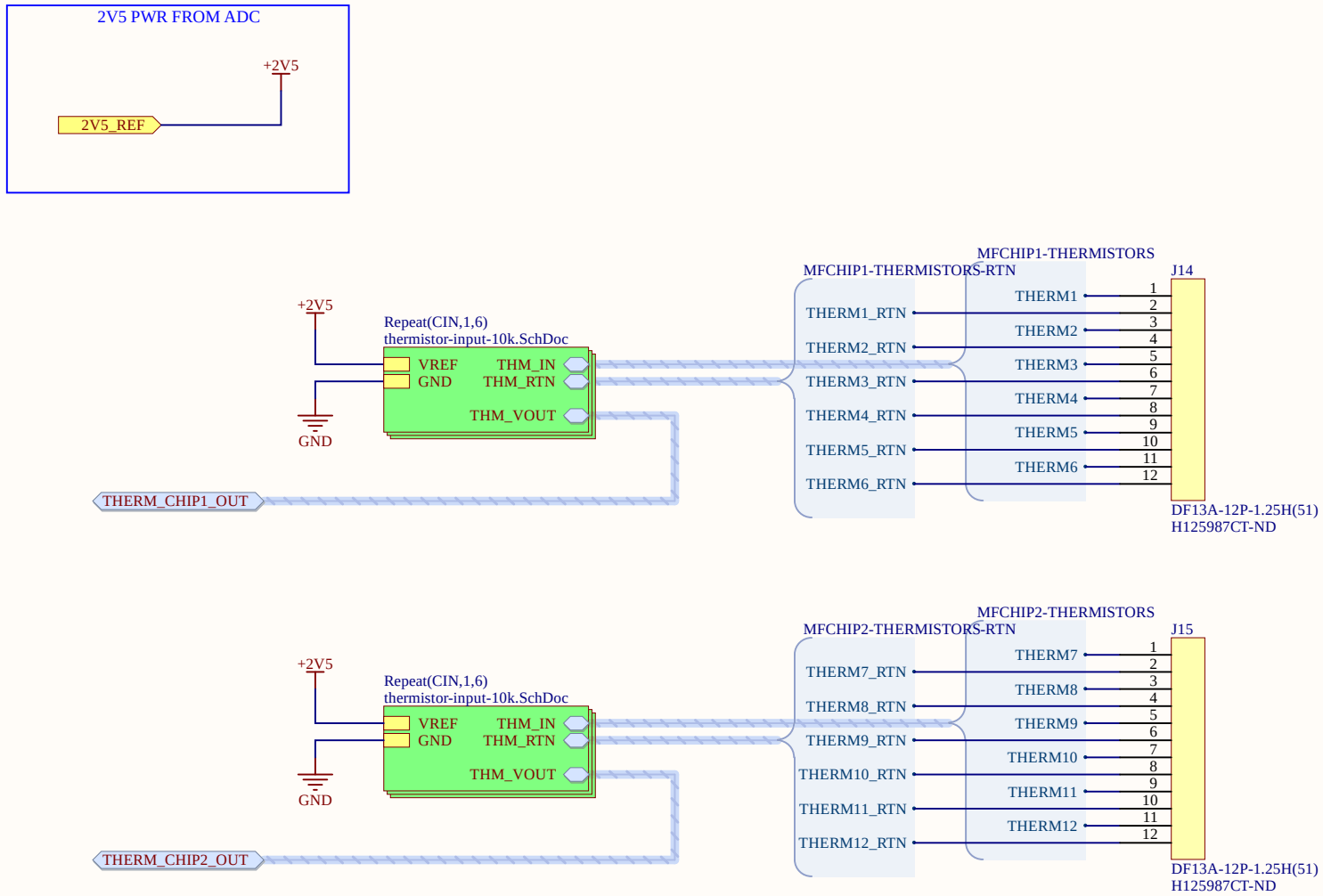
POWER INPUTS



THERMISTOR



Title	thermistor-input-10k.SchDoc	
Size: A4	Number: PCBS-COMMON	Revision: 1.2
Date: 2019-07-24	Sheet * of *	
File: C:\Users\..\thermistor-input-10k.SchDoc	Drawn By: B. Almeida, D. Vogel	



Title		
Size: A4	Number	Revision
Date: 2019-07-24	Sheet of	
File: C:\Users\..\thermistors-connectors.SchDoc	Drawn By:	