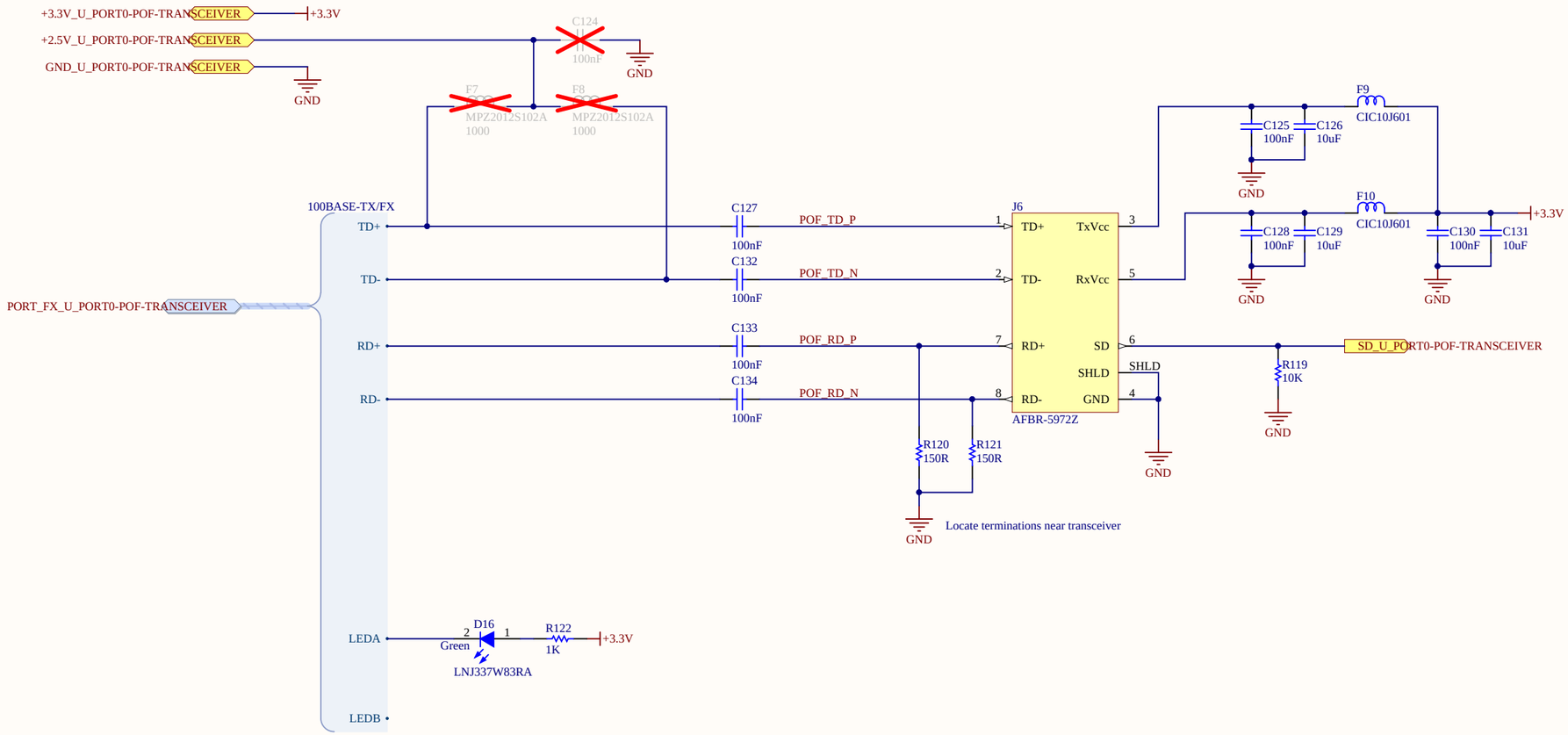
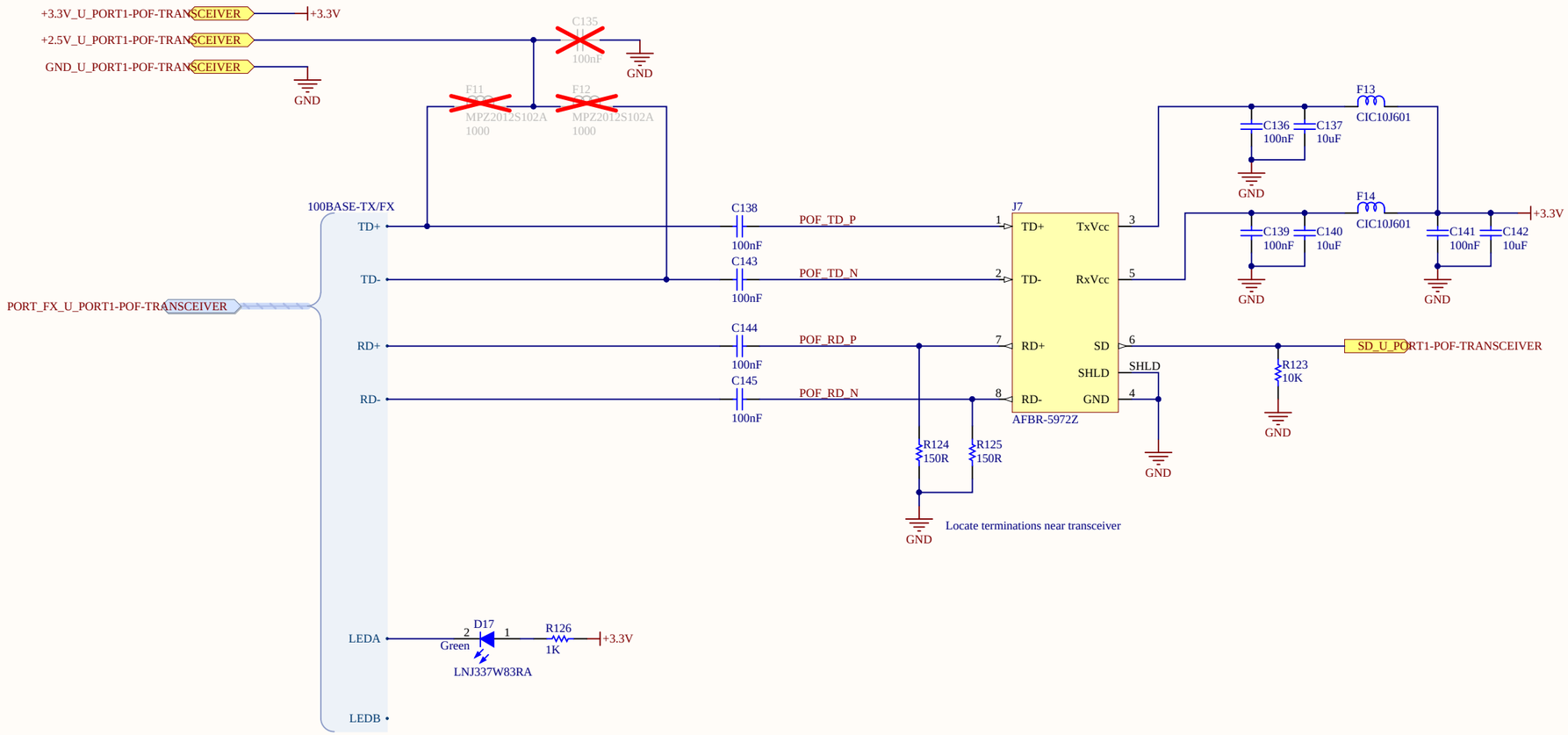


Sheet Title: ***POF FX Transceiver***		***Makani Project*** *Google Inc. 2175 Monarch St. Alameda CA, 94501 USA*
Project Title: ***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:
Date: 7/18/2017 Time: 2:55:27 PM	Sheet .1 of 33	
Author: EAC	File: MMS-0001-00017-B.7.SchDoc	



Sheet Title:	*POF FX Transceiver*
Project Title:	*MTR-CTRL-OZONE-MAIN.PrjPcb*
Size: Tabloid	Number: / Revision:
Date: 7/18/2017 Time: 2:55:27 PM	Sheet 2 of 33
Author: EAC	File: MMS-0001-00017-B.7.SchDoc

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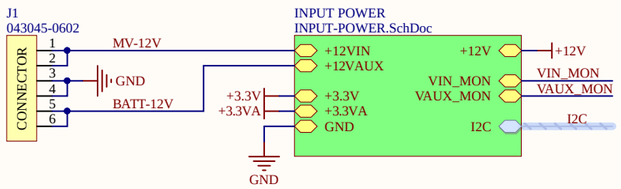
Power Input



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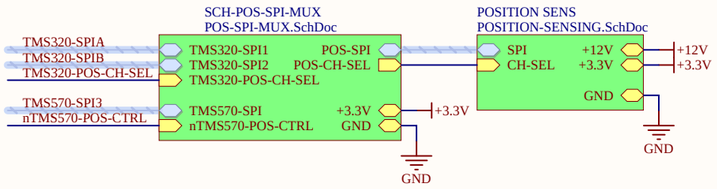
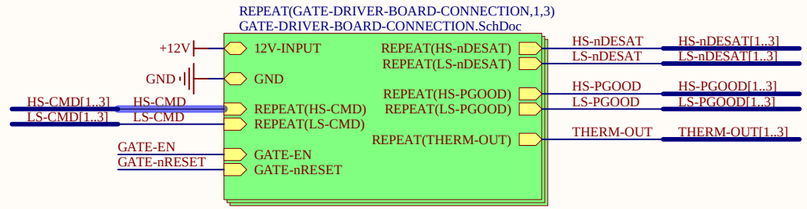
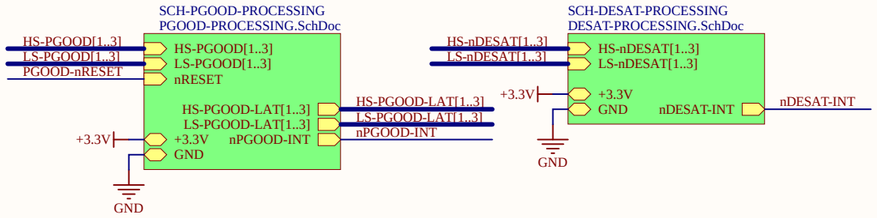
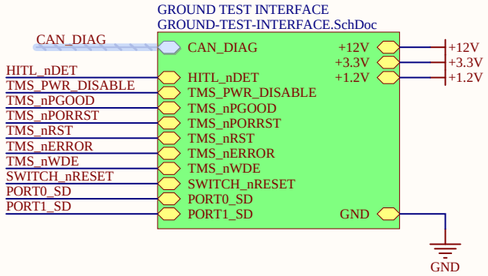


Gate Driver Boards

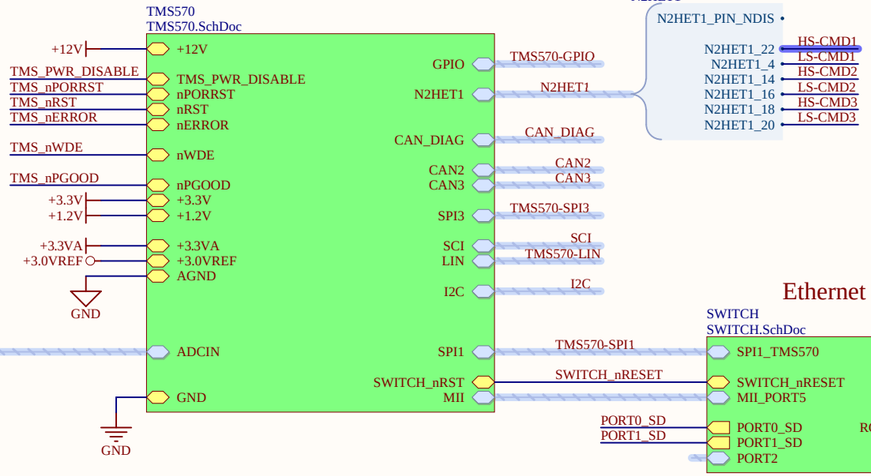




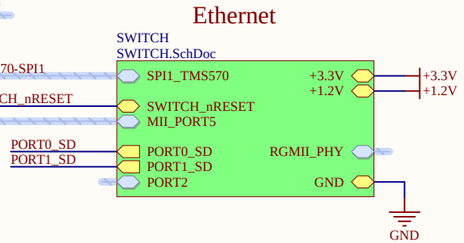
Ground Test Interface



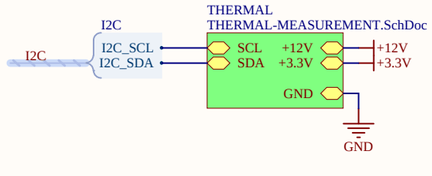
TMS570



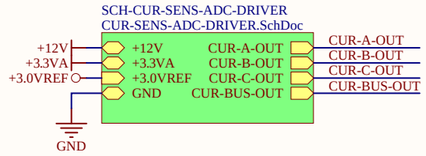
Ethernet



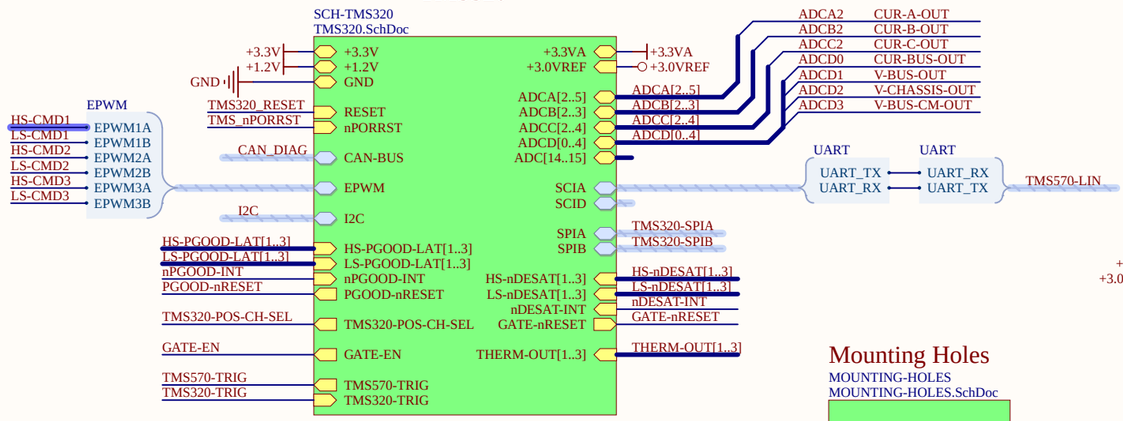
Thermal Measurements



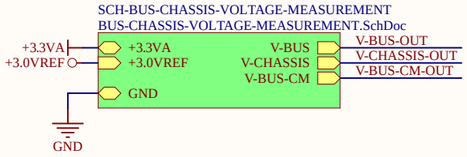
Current Sensors



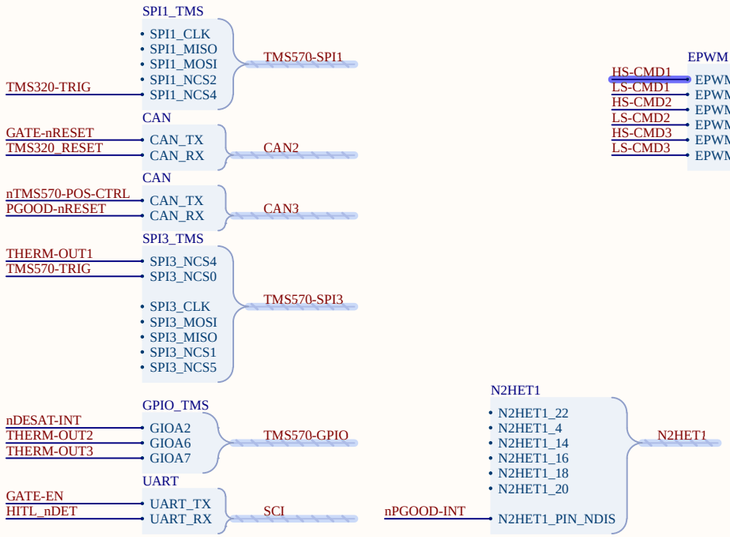
TMS320



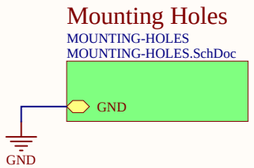
Voltage Measurement



TMS570 GPIO

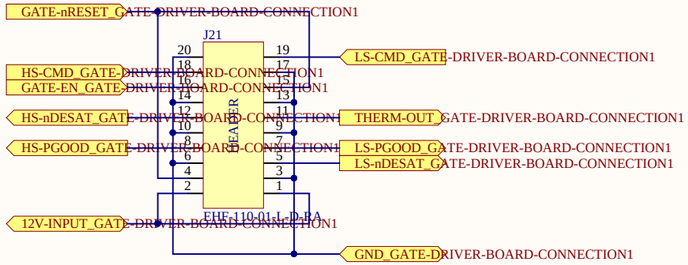


Mounting Holes



Fiducial | Fiducial | Fiducial | Fiducial | Fiducial | Fiducial | Makani Logo

Sheet Title: *Top Level*			**Makani Project**
Project Title: *MTR-CTRL-OZONE-MAIN.PrjPcb*			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 7/18/2017	Time: 2:55:27 PM	Sheet 1 of 33	*Alameda CA, 94501*
Author: ADG	File: TOP-LEVEL-MAIN.SchDoc		*USA*



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Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:28 PM	Sheet 2 of 33	
Author: ADG	File: GATE-DRIVER-BOARD-CONNECTION.SchDoc		

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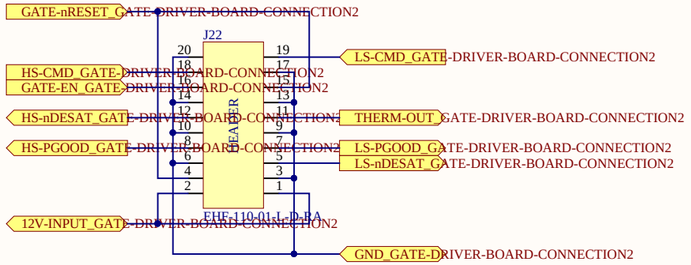

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Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:28 PM	Sheet 3 of 33	
Author: ADG	File: GATE-DRIVER-BOARD-CONNECTION.SchDoc		

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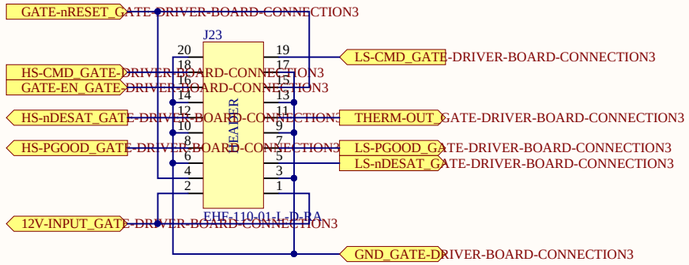

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Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:28 PM	Sheet 4 of 33	
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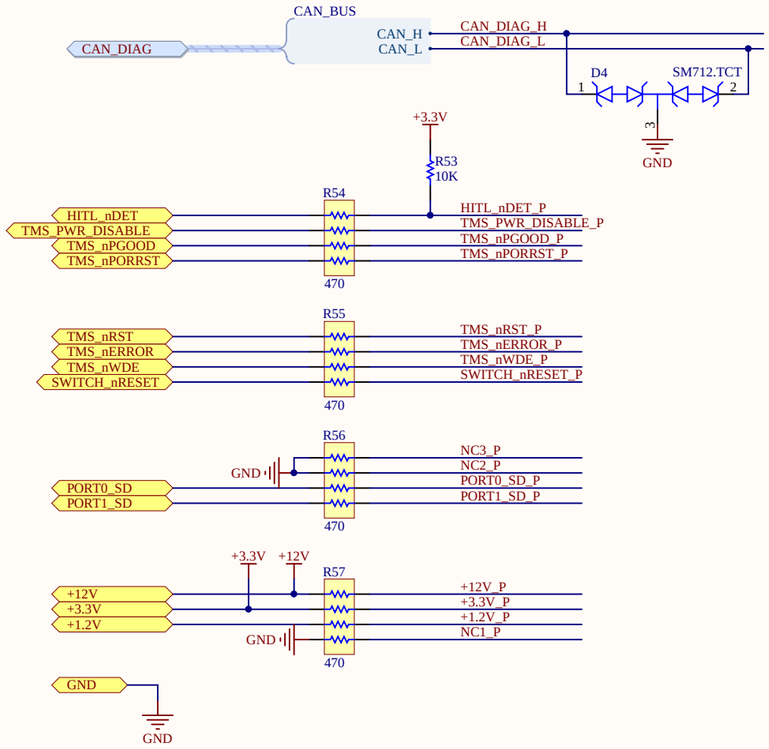

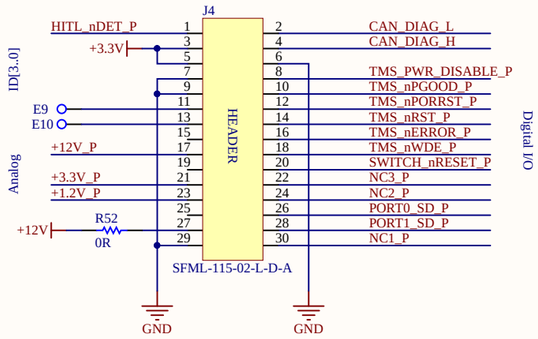

HITL_nDET should be tied to ground on the HITL circuit.

Mating connector is TFSD-15-28-F-XX.XX-DL-NUX

HITL_nDET should be tied to ground on the HITL circuit.

Mating connector is TFSD-15-28-F-XX.XX-DL-NUX

Sheet Title:	***Ground Test Interface***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:28 PM	Sheet 5 of 33	
Author: ADG	File: GROUND-TEST-INTERFACE.SchDoc		

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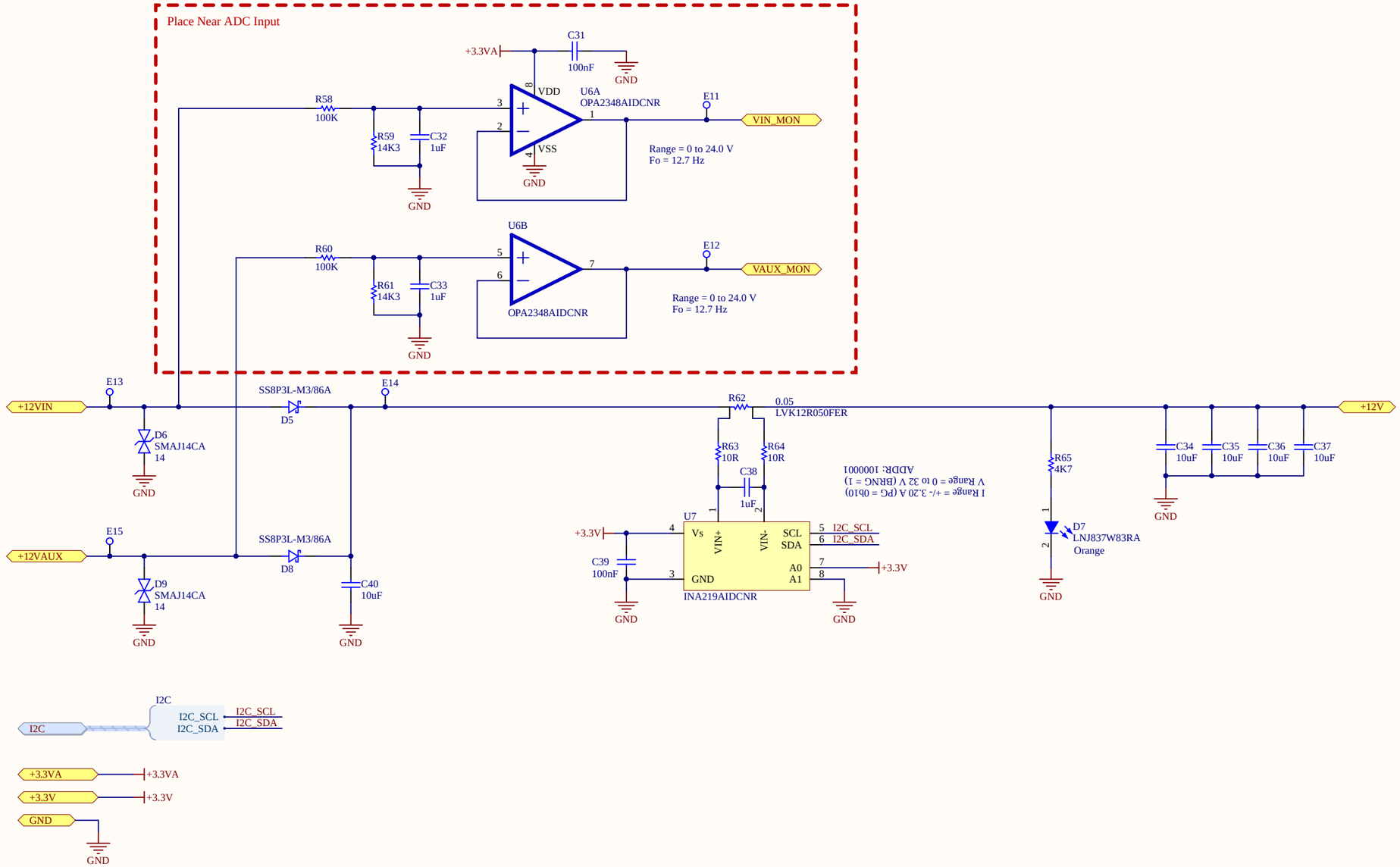

Sheet Title:	*Input Power*
Project Title:	*MTR-CTRL-OZONE-MAIN.PrjPcb*
Size: Tabloid	Number: / Revision:
Date: 7/18/2017	Time: 2:55:28 PM / Sheet 6 of 33
Author: EAC	File: INPUT-POWER.SchDoc

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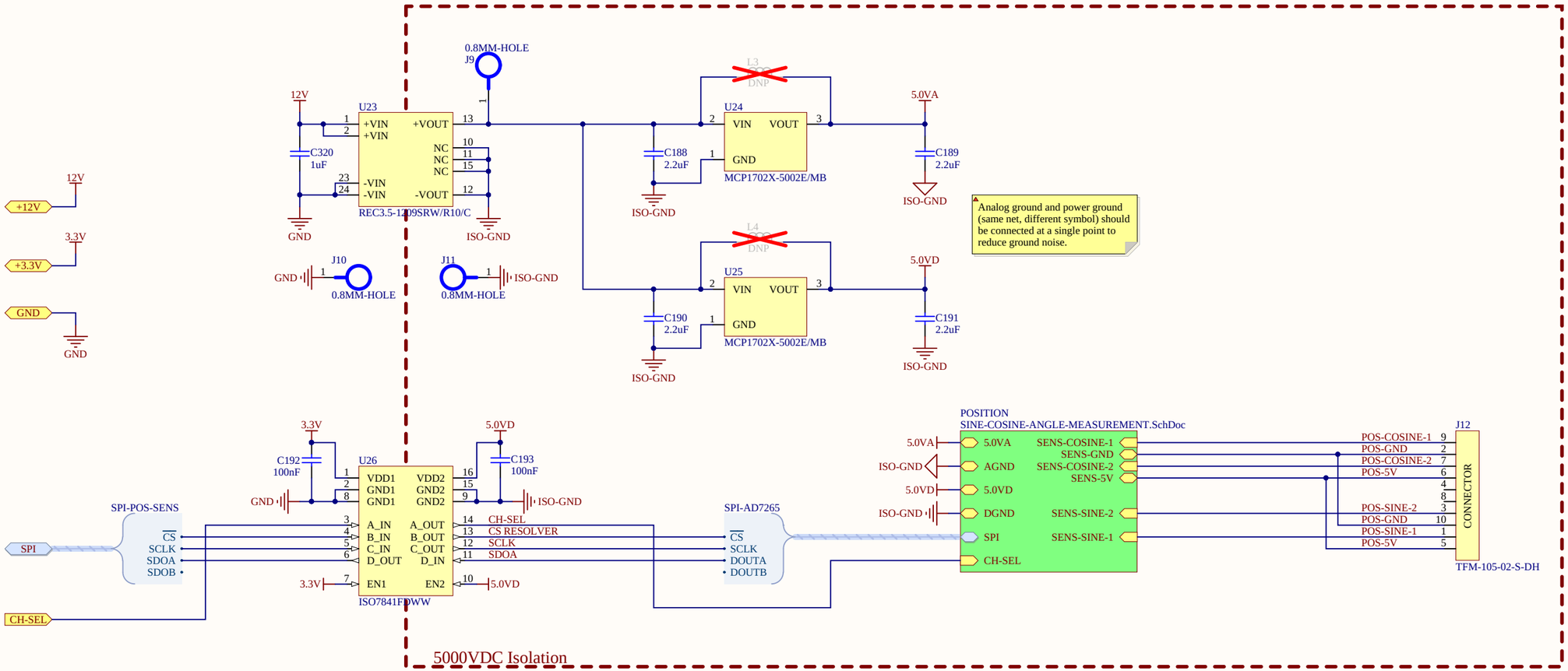

3.3V -- Board 3.3V Supply
12V -- Board 12V Supply
GND -- Board Ground Plane

5.0VA -- Isoltated Analog Supply
5.0VD -- Isolated Digital Supply
AGND -- Isolated Analog Ground Plane (5.0VA)
DGND -- Isolated Digital Ground Plane (5.0VD)

Sheet Title:	***Isolated Position Measurements***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:28 PM	Sheet 7 of 33	
Author: ADG	File: POSITION-SENSING.SchDoc		

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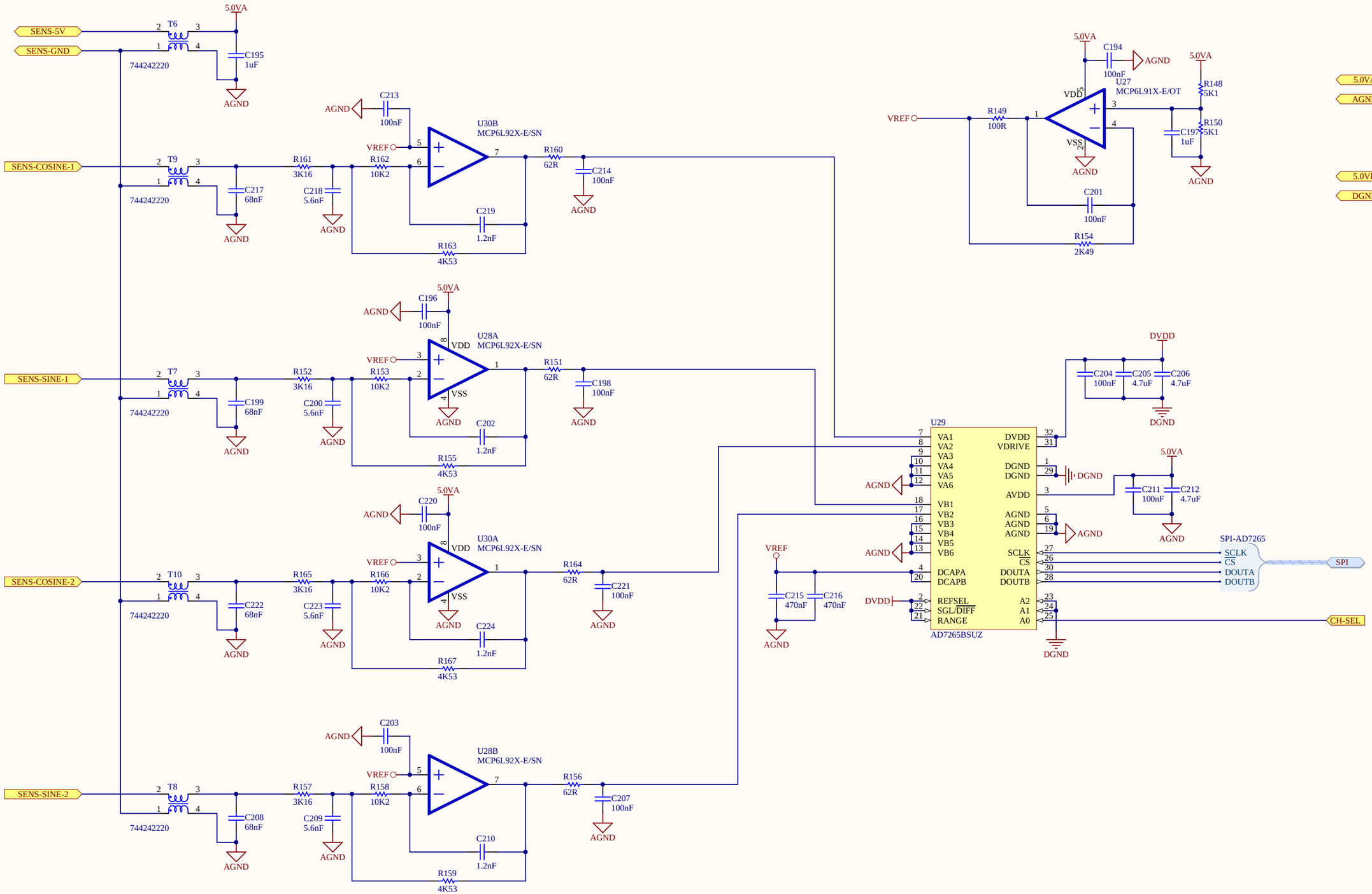

Sheet Title:	*Sin/Cos Position Measurement*
Project Title:	*MTR-CTRL-OZONE-MAIN.PrjPcb*
Size: Tabloid	Number: / Revision:
Date: 7/18/2017	Time: 2:55:28 PM / Sheet 8 of 33
Author: ADG	File: SINE-COSINE-ANGLE-MEASUREMENT.SchDoc

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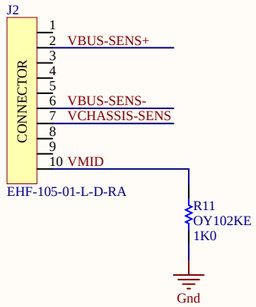
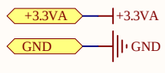
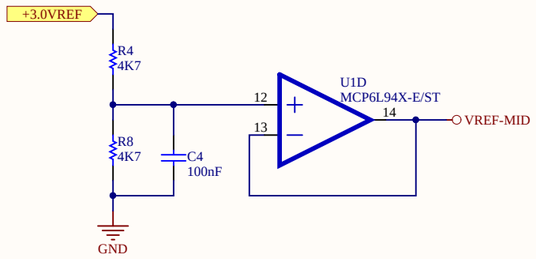
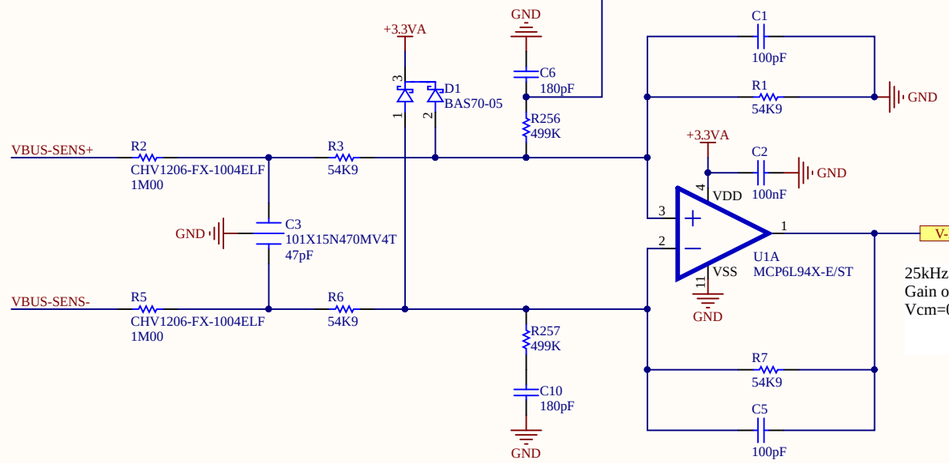


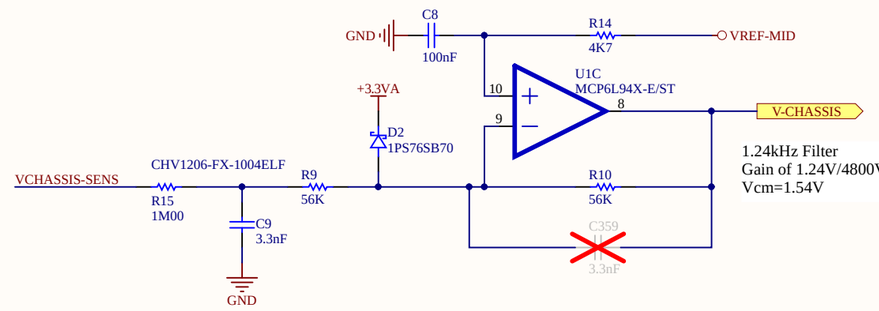






Bus voltage common mode
Gain of 2.698V/4000V(CM) Vcm=0V
BW=1.57kHz
Should equel 1/2 of bus differential voltage in normal operation

25kHz Difference Amplifier
Gain of 2.696V/2000V (Diff)
Vcm=0V BW=25kHz



1.24kHz Filter
Gain of 1.24V/4800V
Vcm=1.54V

Notes:
1. Filter caps (100pF, 180pF, 3nF,) are 5% NPO/C0G type
2. All SMD component using IPC medium density footprint
3. Resistors are used on common model measurement amplifier to scale Vcom to Vdiff/2

Sheet Title:	***Bus&Chassis Voltage Measurement***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:29 PM	Sheet 9 of 33	
Author: TT	File: BUS-CHASSIS-VOLTAGE-MEASUREMENT.SchDoc		

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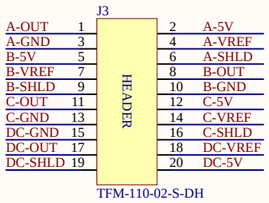

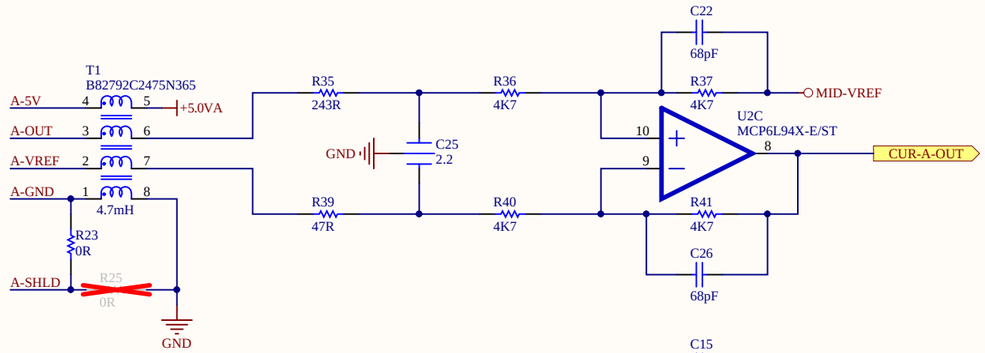

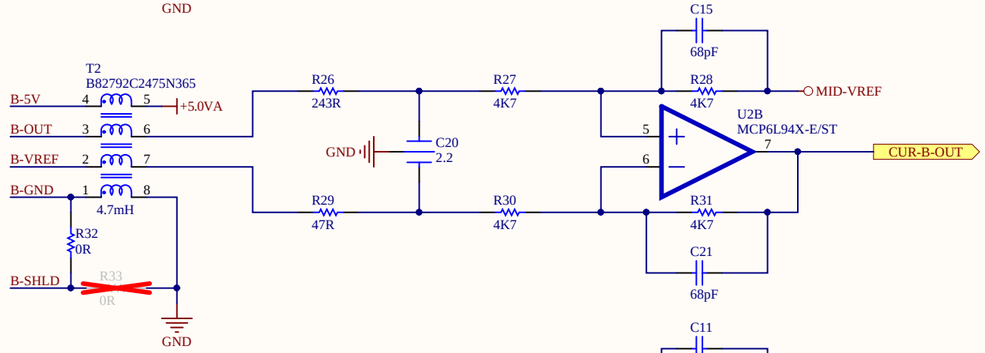

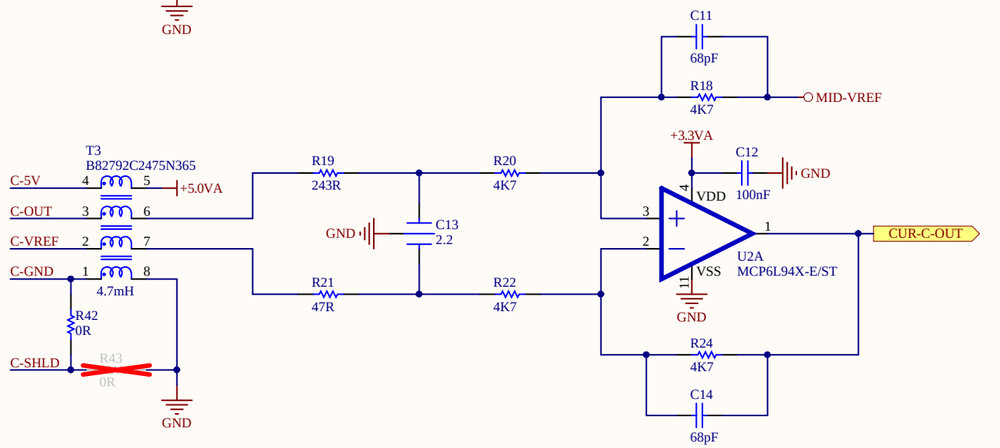

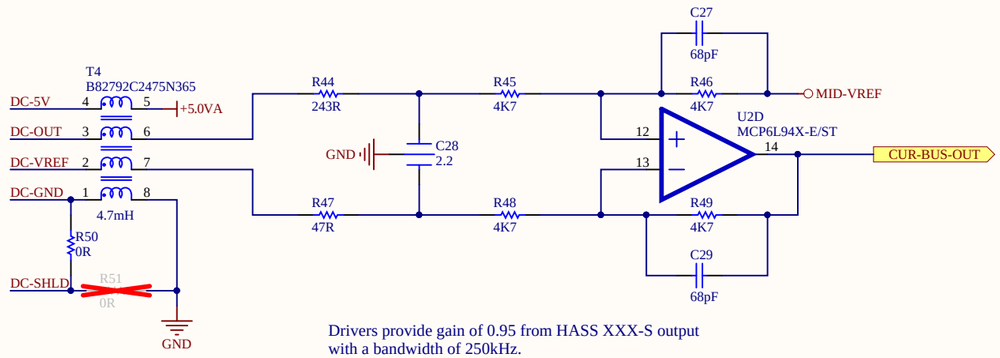

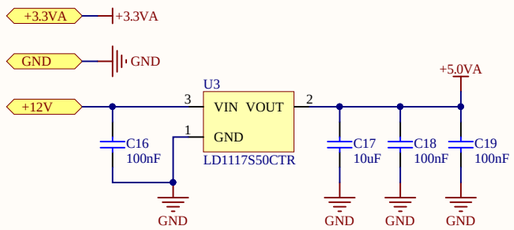

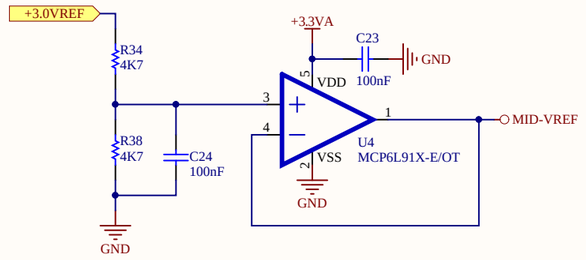

Drivers provide gain of 0.95 from HASS XXX-S output with a bandwidth of 250kHz.

Sheet Title:	***Current Sensor ADC Driver***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:29 PM	Sheet 10 of 33	
Author: ADG	File: CUR-SENS-ADC-DRIVER.SchDoc		

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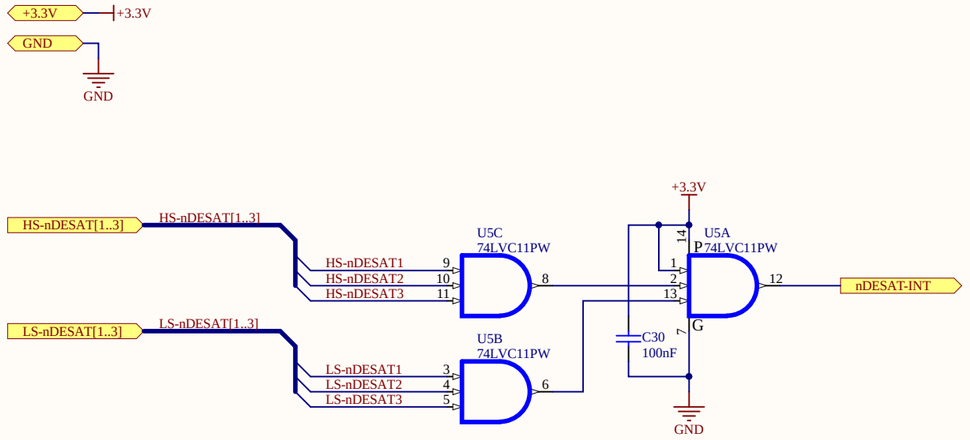

Sheet Title:	***GDB nDESAT Fault Processing***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:29 PM	Sheet 11 of 33	
Author: ADG	File: DESAT-PROCESSING.SchDoc		

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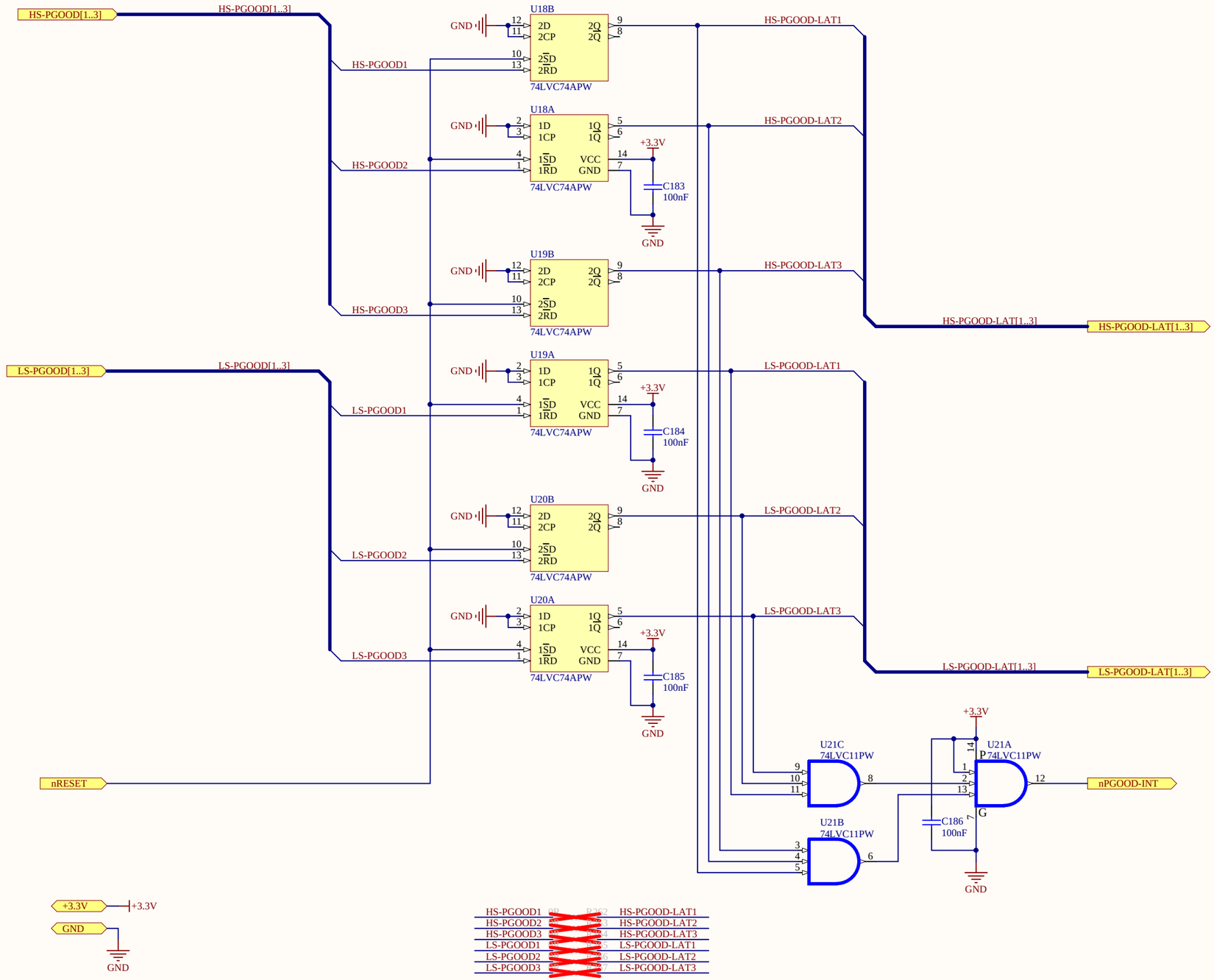
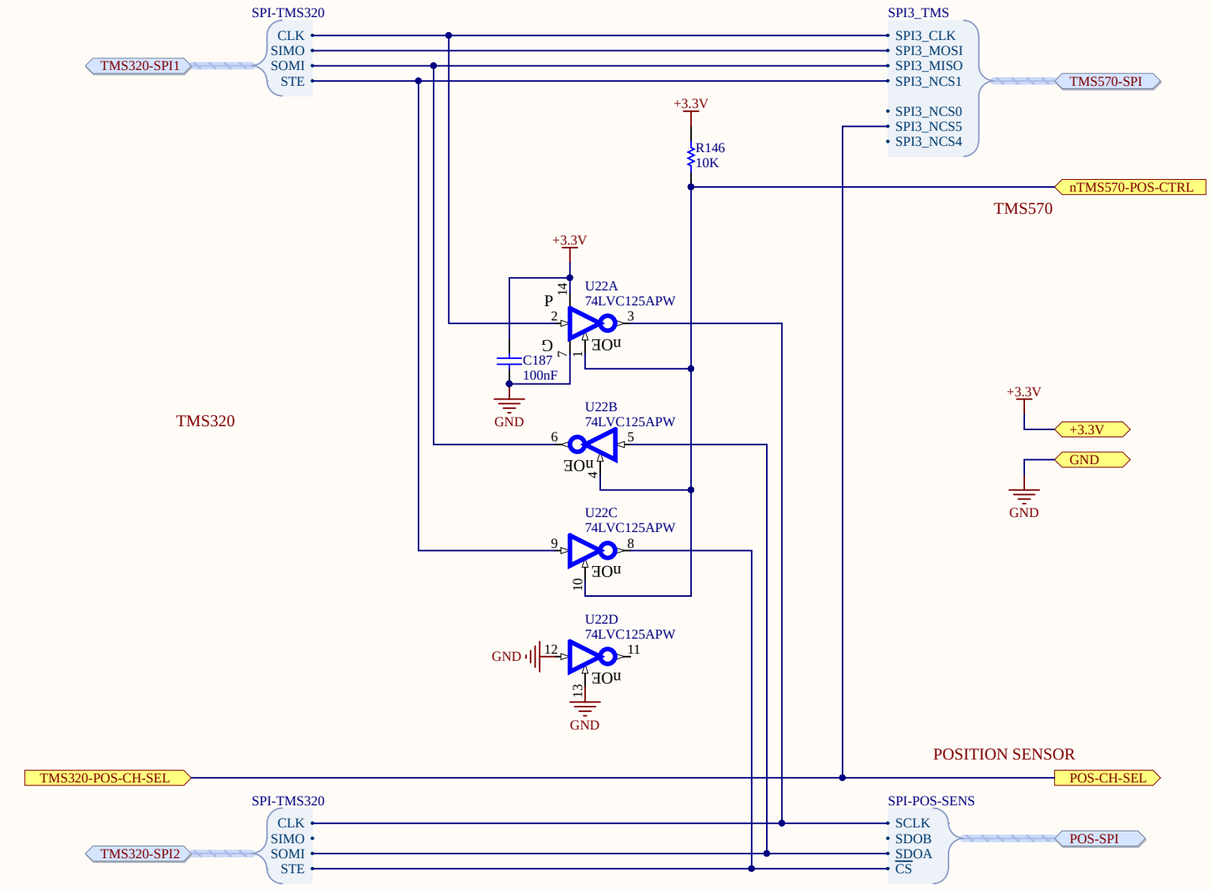


DNP resistors are available to bypass latching behavior and utilize the TMS320's glitch filtering.

Sheet Title: *GDB PGOOD Fault Processing*		**Makani Project**
Project Title: *MTR-CTRL-OZONE-MAIN.PrjPcb*		*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 7/18/2017 Time: 2:55:29 PM	Sheet 12 of 33	*Alameda CA, 94501*
Author: ADG	File: PGOOD-PROCESSING.SchDoc	*USA*

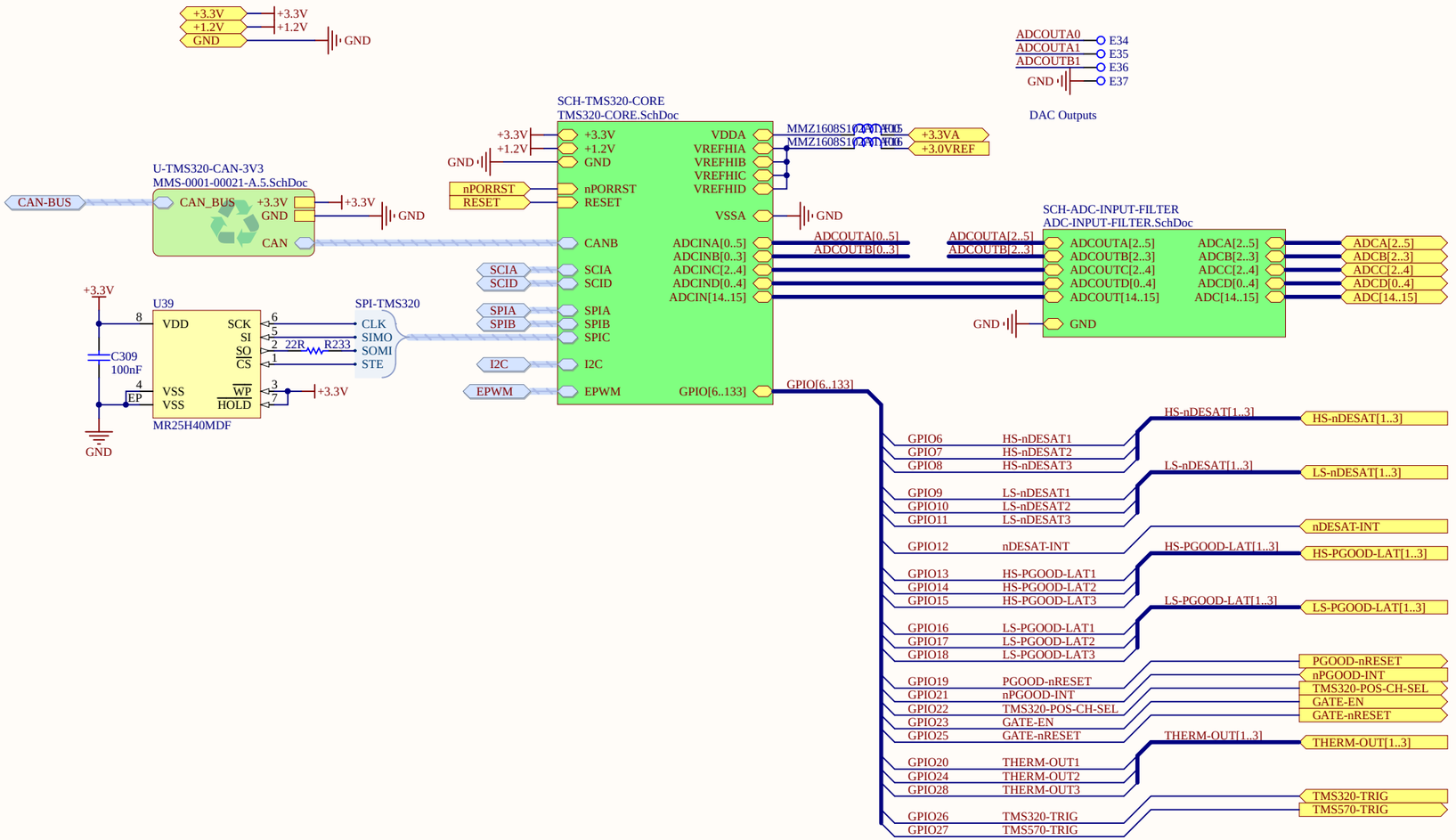


During TMS570 only operation this circuit allows the TMS570 to control the position sensor SPI bus.

During dual TMS570 and TMS320 operation this circuit allows the TMS570 to communicate to the TMS320 via SPI1 and allows the TMS320 to control the position sensor SPI bus through SPI2.

The mode change is controlled by the TMS570 via nTMS570-POS-CTRL.

Sheet Title: *Position Sensor SPI Buffer/Mux*			*Makani Project*
Project Title: *MTR-CTRL-OZONE-MAIN.PrjPcb*			*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:29 PM	Sheet 13 of 33	
Author: ADG	File: POS-SPI-MUX.SchDoc		



Sheet Title:	***TMS320 Template***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:29 PM	Sheet 14 of 33	
Author: ADG	File: TMS320.SchDoc		

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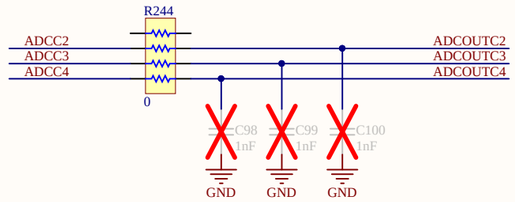

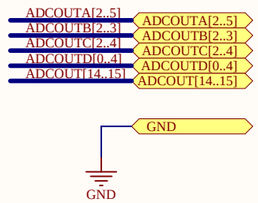

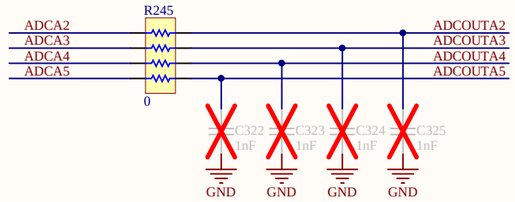

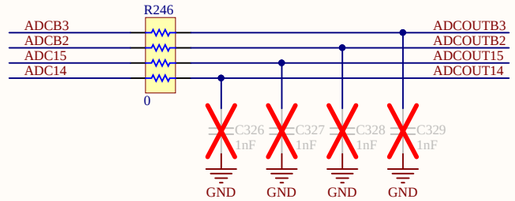

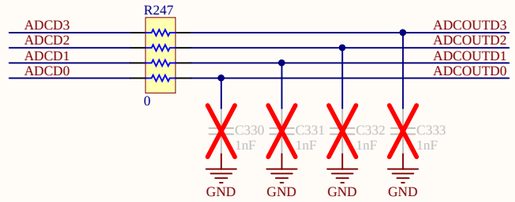

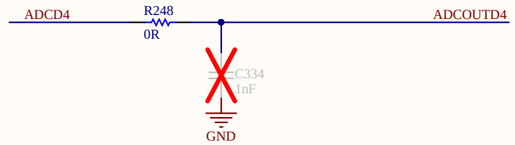

Sheet Title:	***TMS320 ADC Input Filter***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:30 PM	Sheet 15 of 33	
Author: ADG	File: ADC-INPUT-FILTER.SchDoc		

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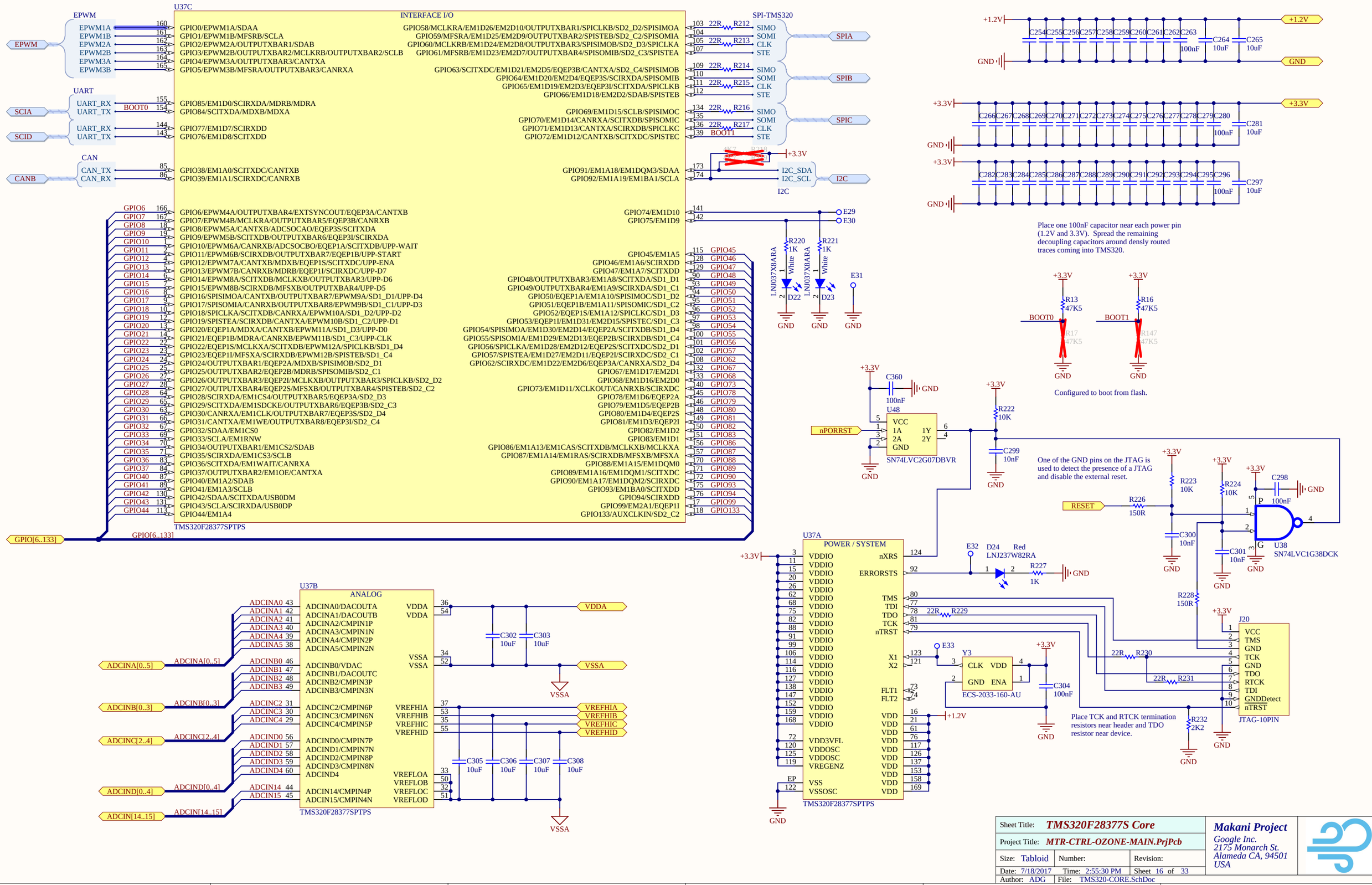

Sheet Title:	TMS320F28377S Core
Project Title:	MTR-CTRL-OZONE-MAIN.PrjPcb
Size: Tabloid	Number: / Revision:
Date: 7/18/2017	Time: 2:55:30 PM / Sheet 16 of 33
Author: ADG	File: TMS320-CORE.SchDoc

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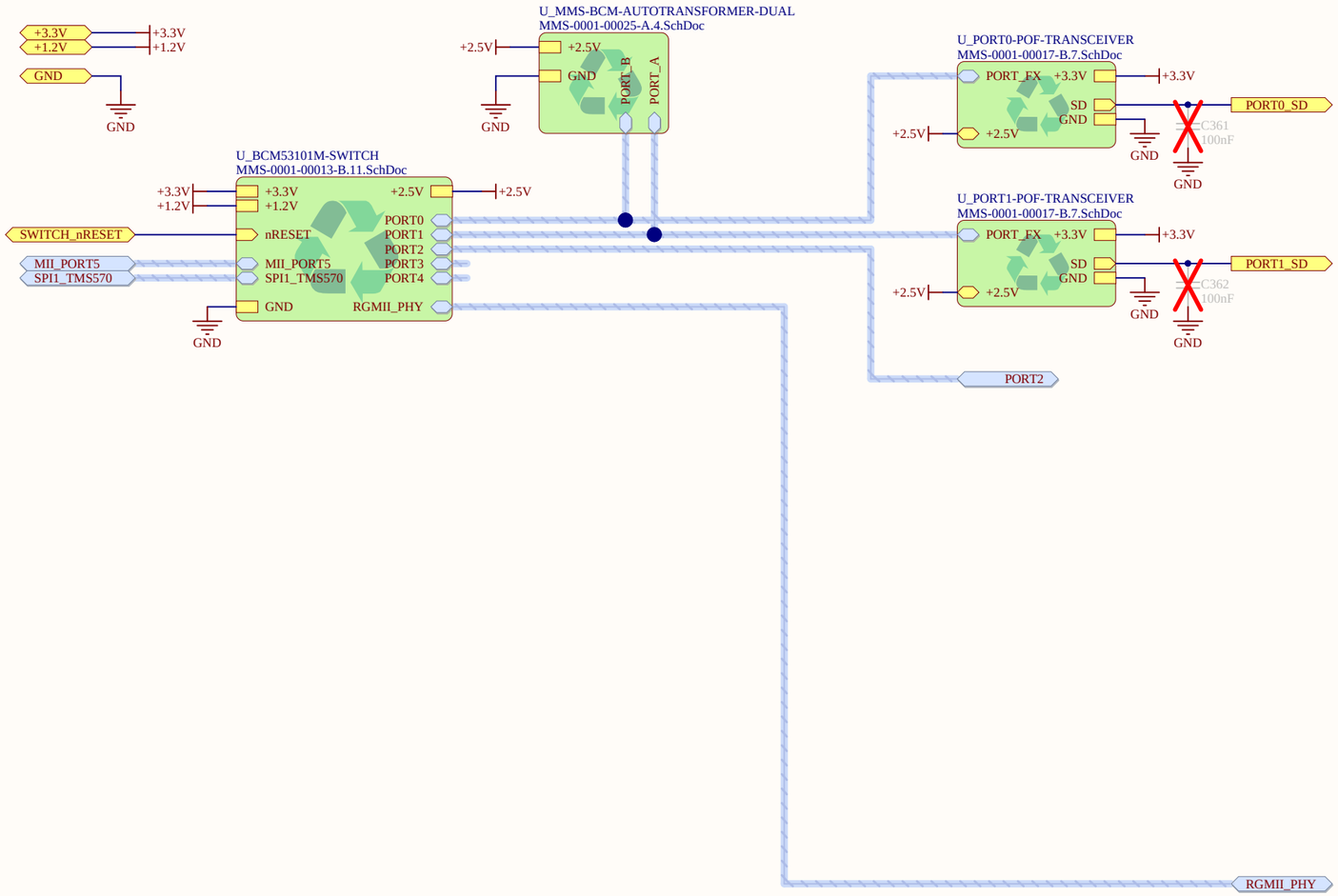

Sheet Title:	***Switch and transceivers***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:30 PM	Sheet 18 of 33	
Author: EAC	File: SWITCH.SchDoc		

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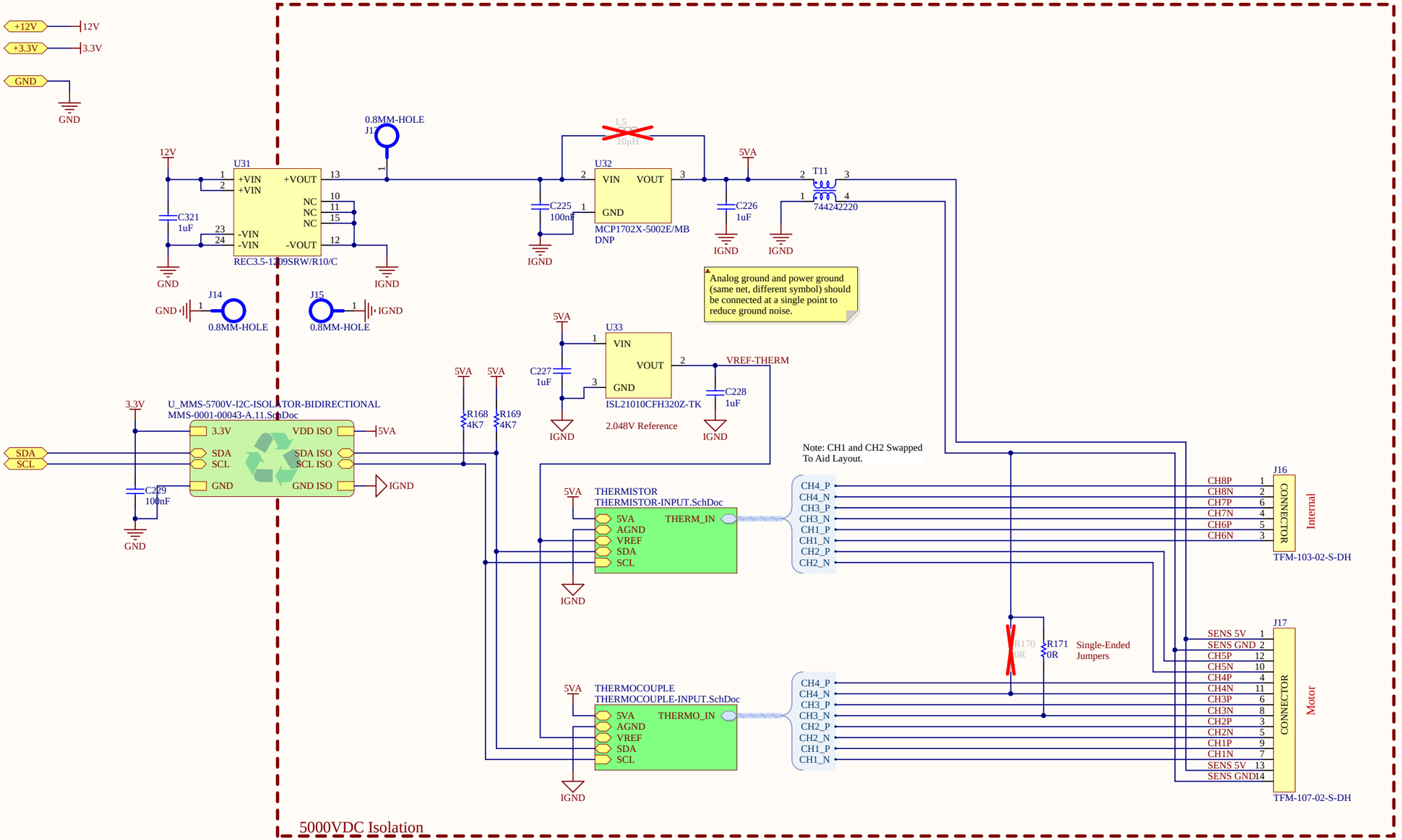
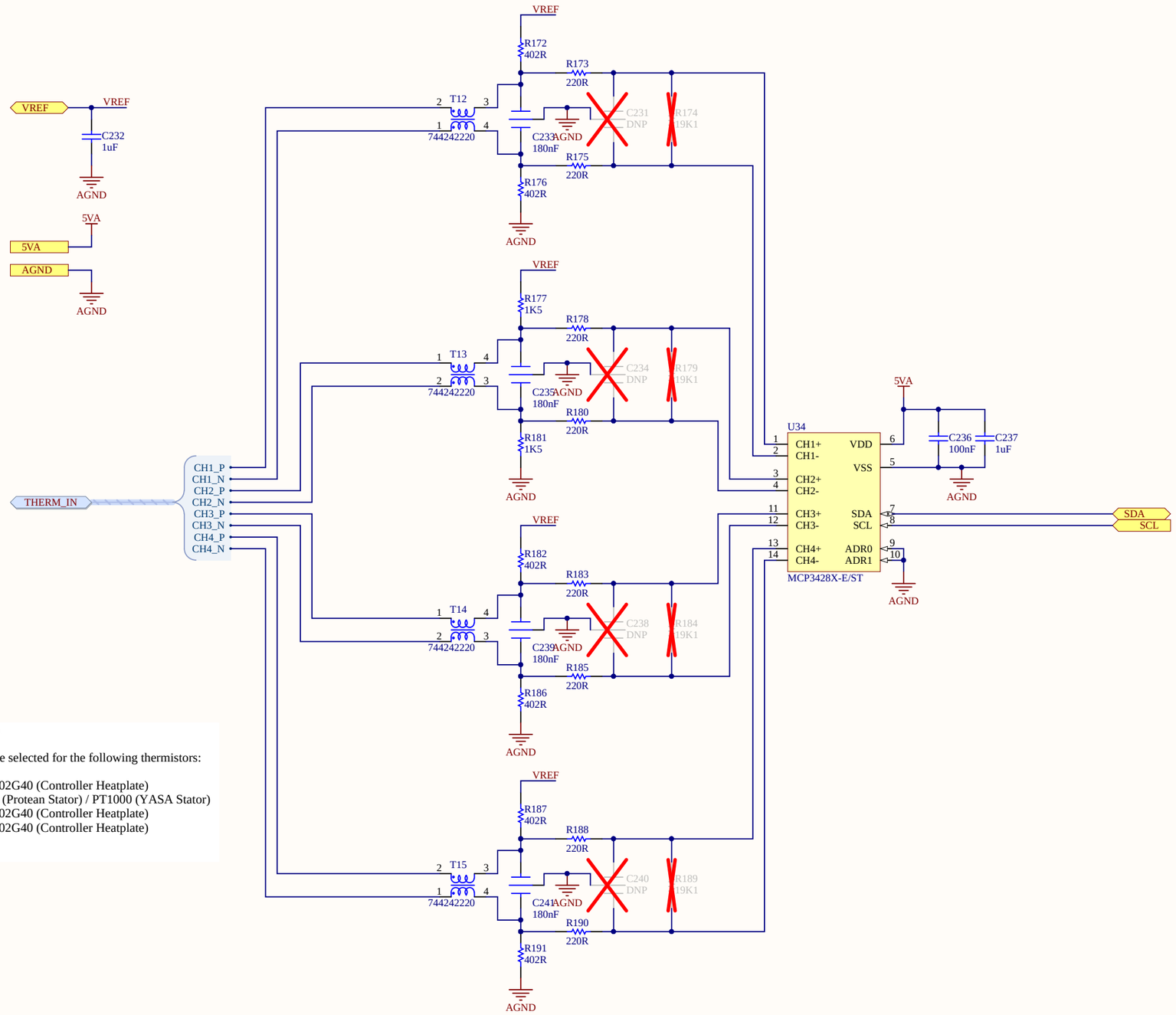


3.3V -- Board 3.3V Supply
12V -- Board 12V Supply
GND -- Board Ground Plane

5VA -- Isoltated Analog Supply
AGND -- Isolated Analog Ground Plane

Sheet Title: *Isolated Temp Measurements*			**Makani Project**
Project Title: *MTR-CTRL-OZONE-MAIN.PrjPcb*			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 7/18/2017	Time: 2:55:30 PM	Sheet 23 of 33	*Alameda CA, 94501*
Author: ADG	File: THERMAL-MEASUREMENT.SchDoc		*USA*

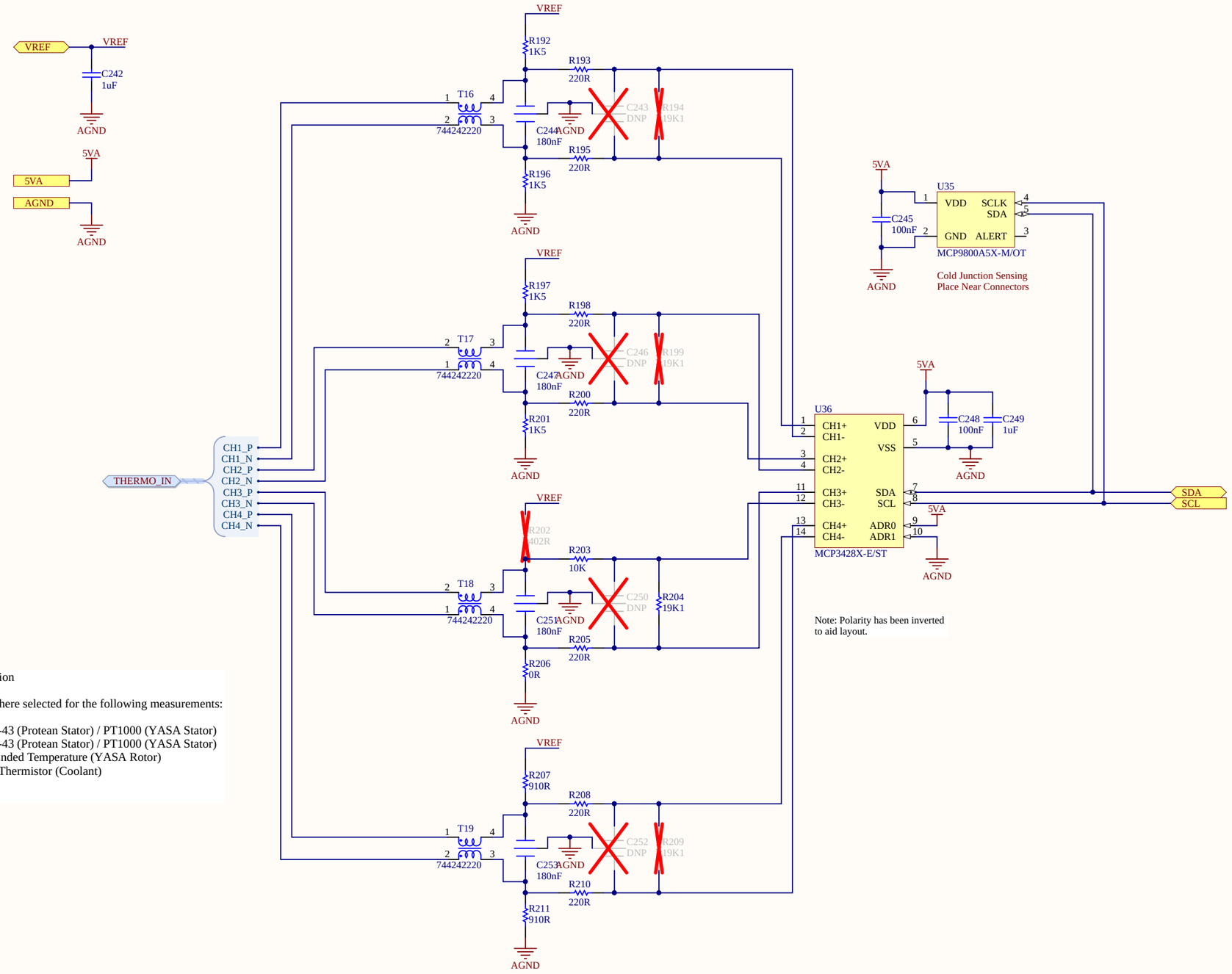


Bias Resistor Selection

The bias resistors where selected for the following thermistors:

Channel 1: B57703M502G40 (Controller Heatplate)
Channel 2: NSII E1-43 (Protean Stator) / PT1000 (YASA Stator)
Channel 3: B57703M502G40 (Controller Heatplate)
Channel 4: B57703M502G40 (Controller Heatplate)

Sheet Title: *4-Ch Thermistor Measurement*		**Makani Project**
Project Title: *MTR-CTRL-OZONE-MAIN.PrjPcb*		*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number:	Revision:
Date: 7/18/2017 Time: 2:55:31 PM	Sheet 24 of 33	
Author: ADG	File: THERMISTOR-INPUT.SchDoc	



Sheet Title:	***4-Ch Temperature Measurement***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:31 PM	Sheet 25 of 33	
Author: ADG	File: THERMOCOUPLE-INPUT.SchDoc		

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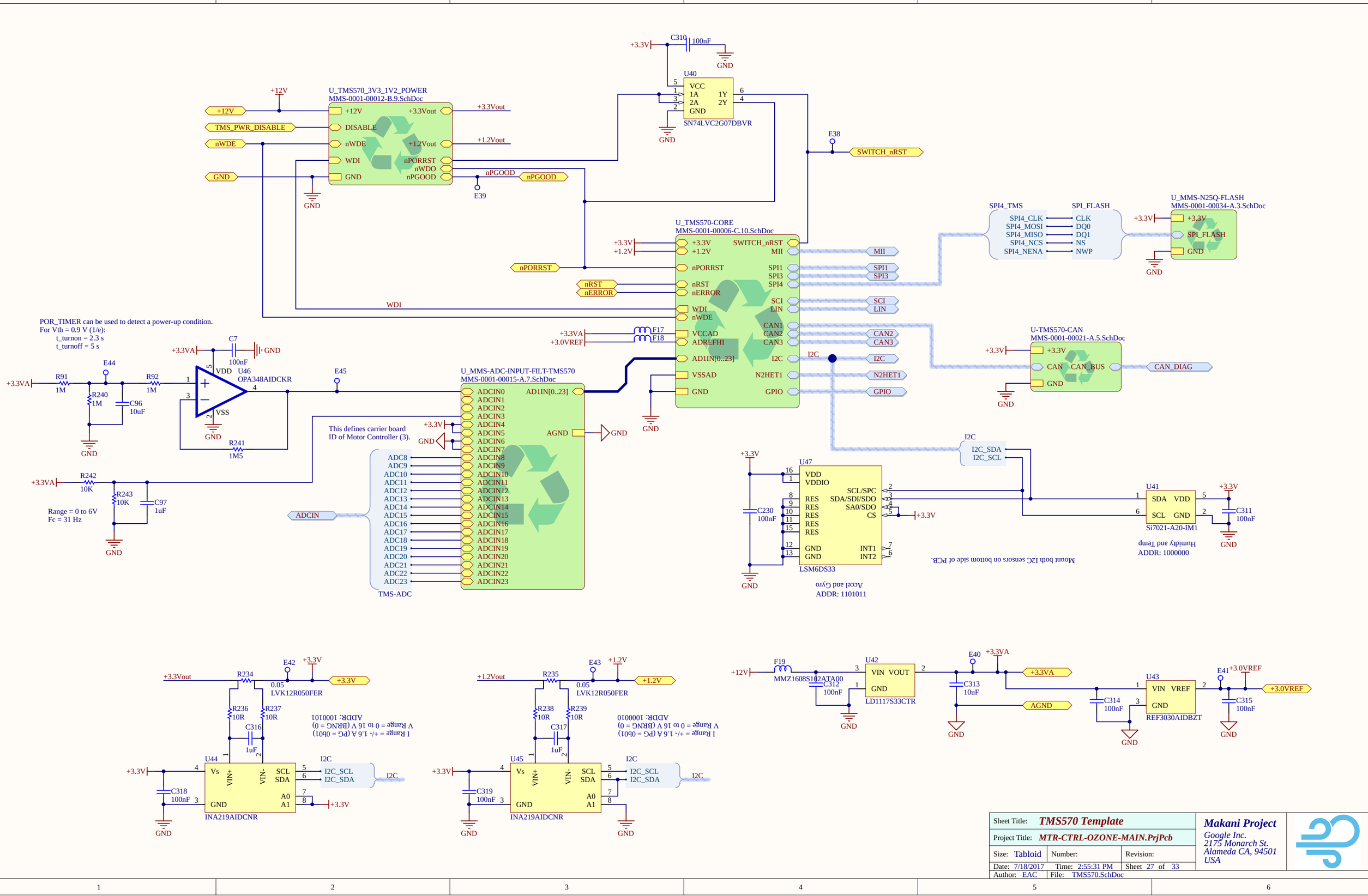

Sheet Title:	*TMS570 Template*
Project Title:	*MTR-CTRL-OZONE-MAIN.PrjPcb*
Size: Tabloid	Number: / Revision:
Date: 7/18/2017	Time: 2:55:31 PM / Sheet 27 of 33
Author: EAC	File: TMS570.SchDoc

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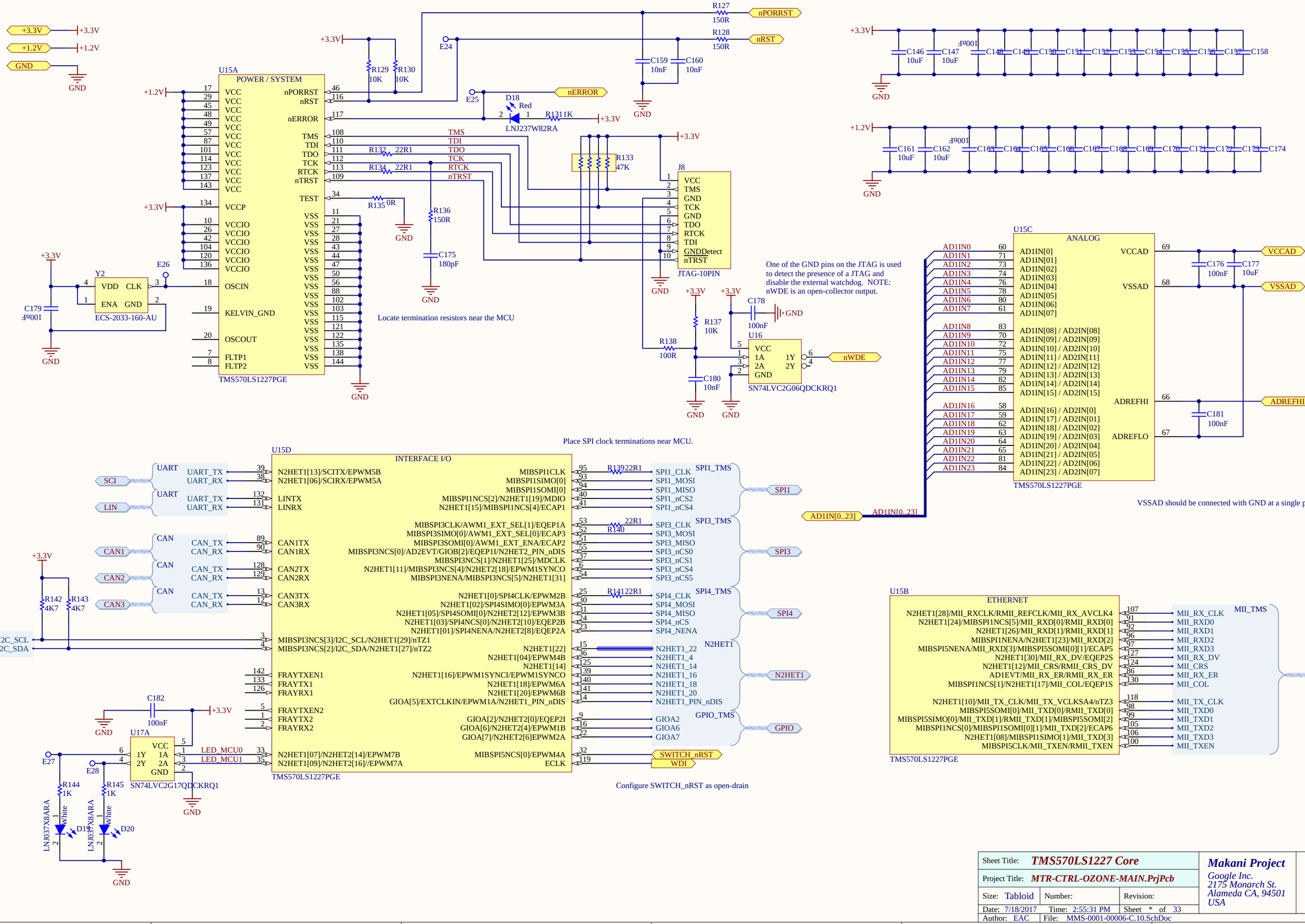

Sheet Title:	*TMS570LS1227 Core*
Project Title:	*MTR-CTRL-OZONE-MAIN.PrjPcb*
Size: Tabloid	Number: / Revision:
Date: 7/18/2017	Time: 2:55:31 PM / Sheet * of 33
Author: EAC	File: MMS-0001-00006-C.10.SchDoc

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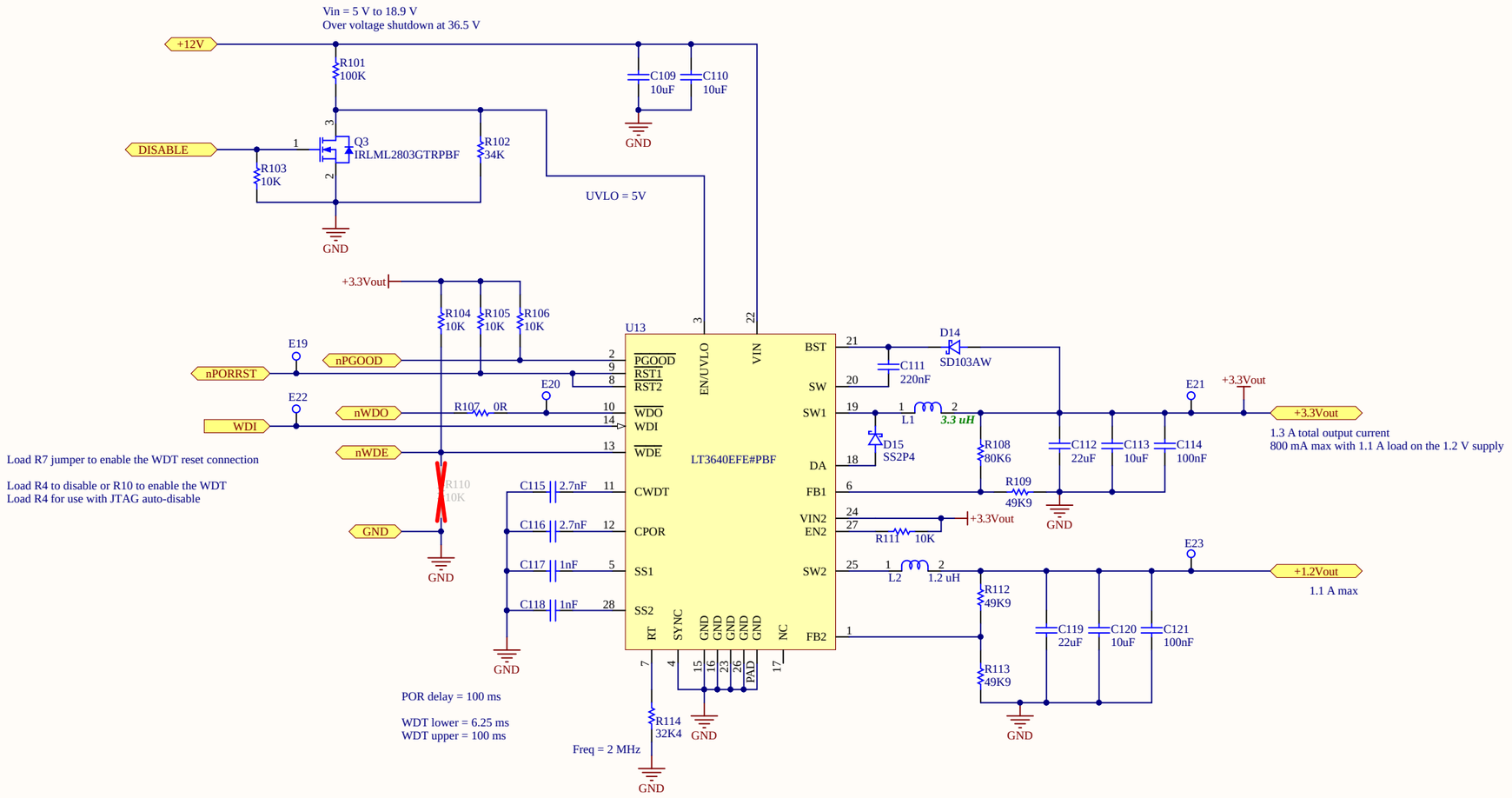

Sheet Title:	*LT3640 3V3 1V2*		
Project Title:	*MTR-CTRL-OZONE-MAIN.PrjPcb*		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:32 PM	Sheet * of 33	
Author: EAC	File: MMS-0001-00012-B.9.SchDoc		

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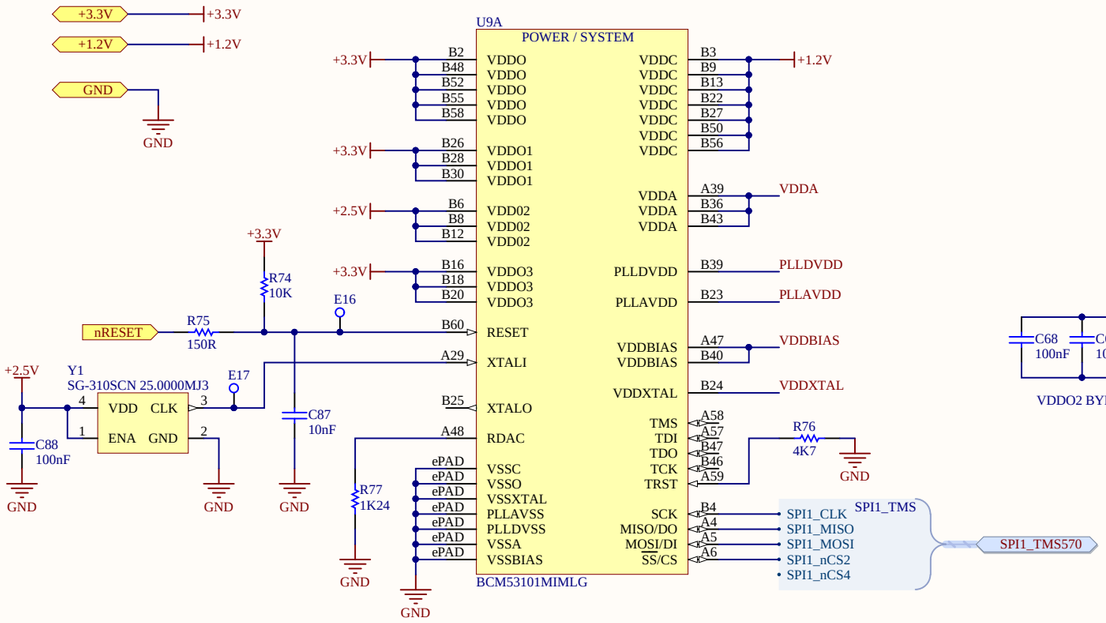

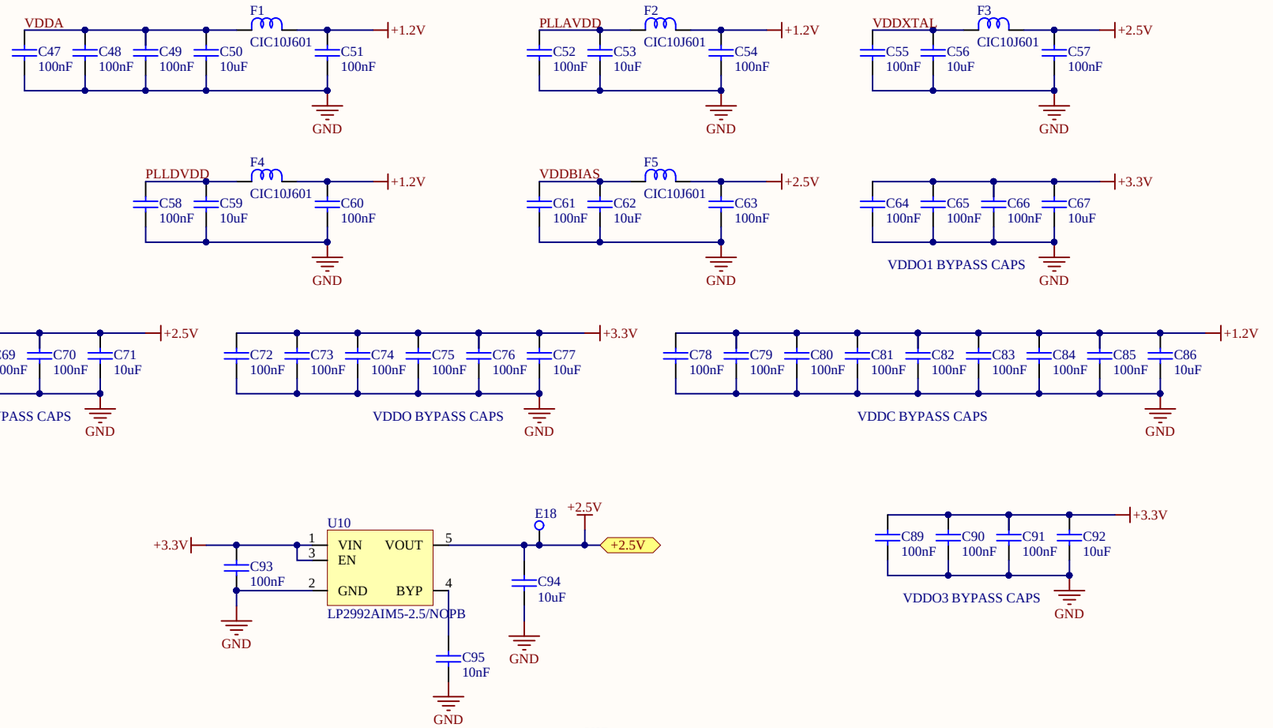

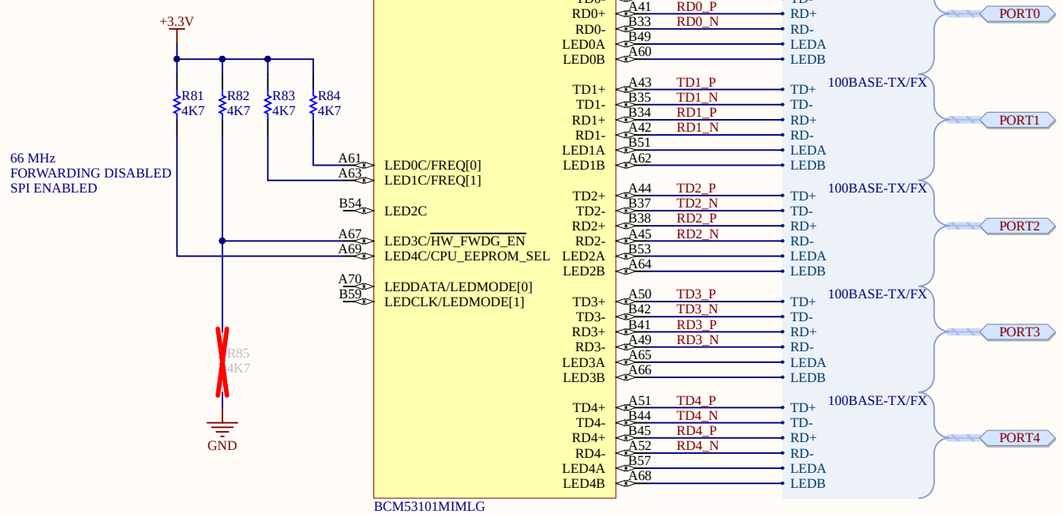

Sheet Title:	BCM53101M SWITCH
Project Title:	MTR-CTRL-OZONE-MAIN.PrjPcb
Size: Tabloid	Number: / Revision:
Date: 7/18/2017	Time: 2:55:32 PM / Sheet * of 33
Author: EAC	File: MMS-0001-00013-B.11.SchDoc

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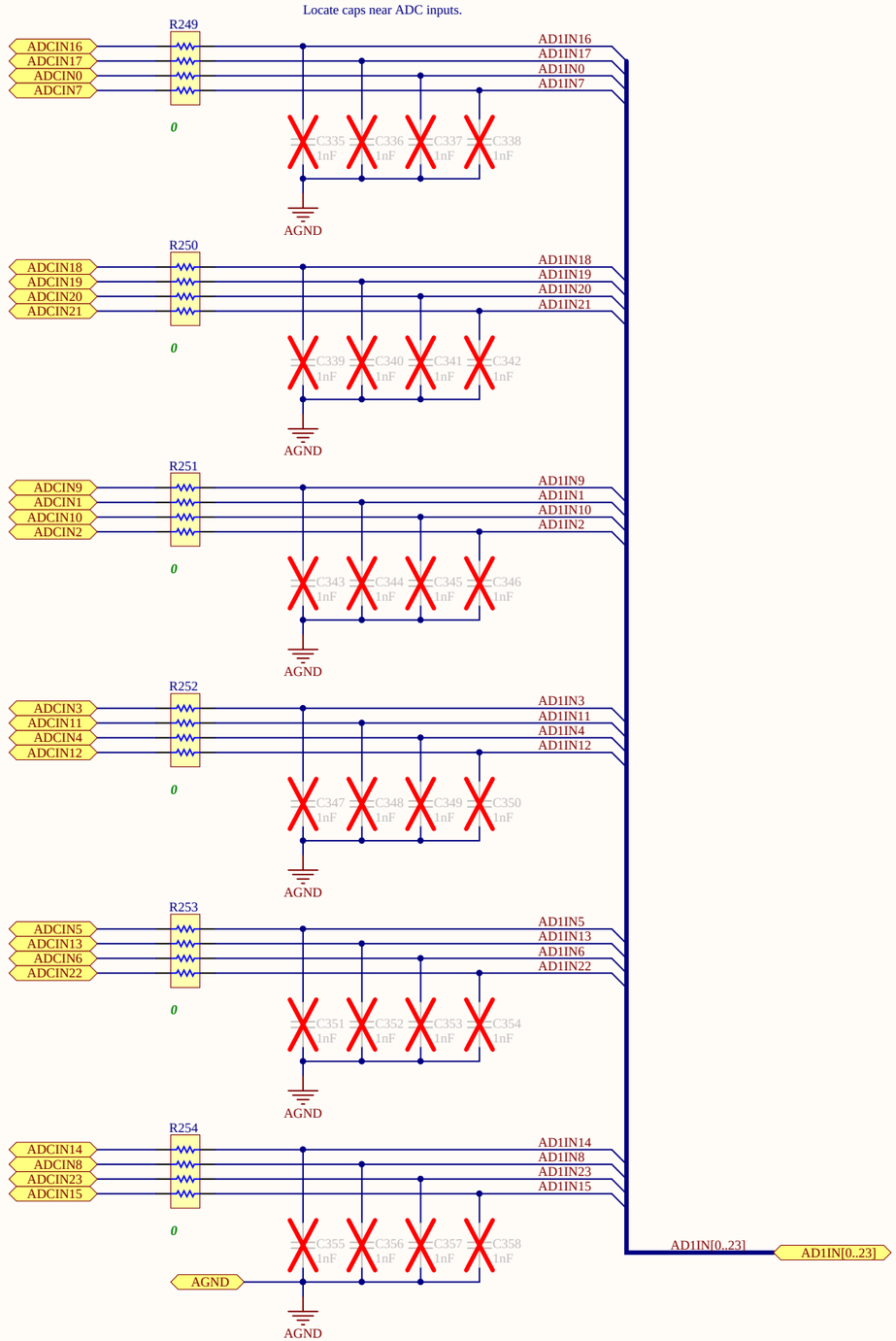

Sheet Title:	***TMS570 ADC INPUT FILTER***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:32 PM	Sheet * of 33	
Author: EAC	File: MMS-0001-00015-A.7.SchDoc		

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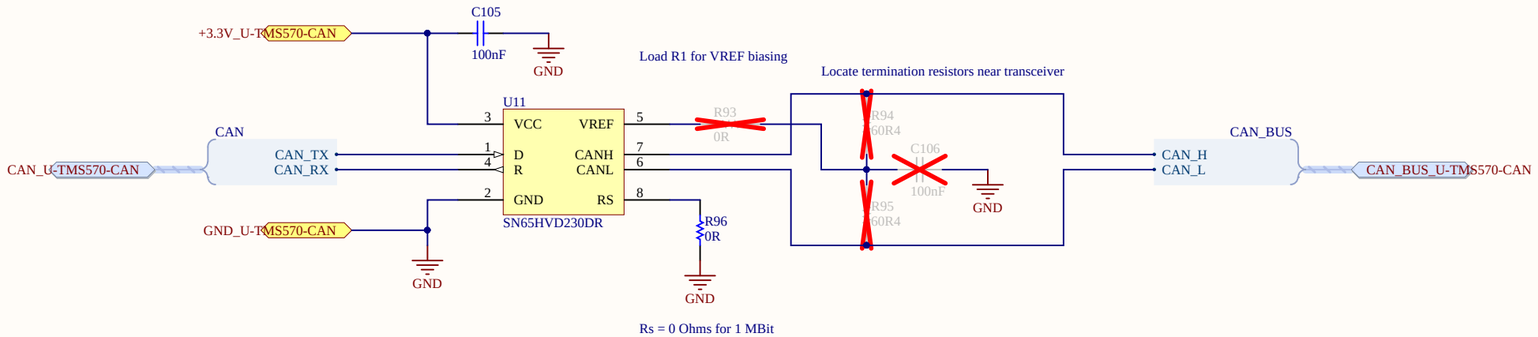
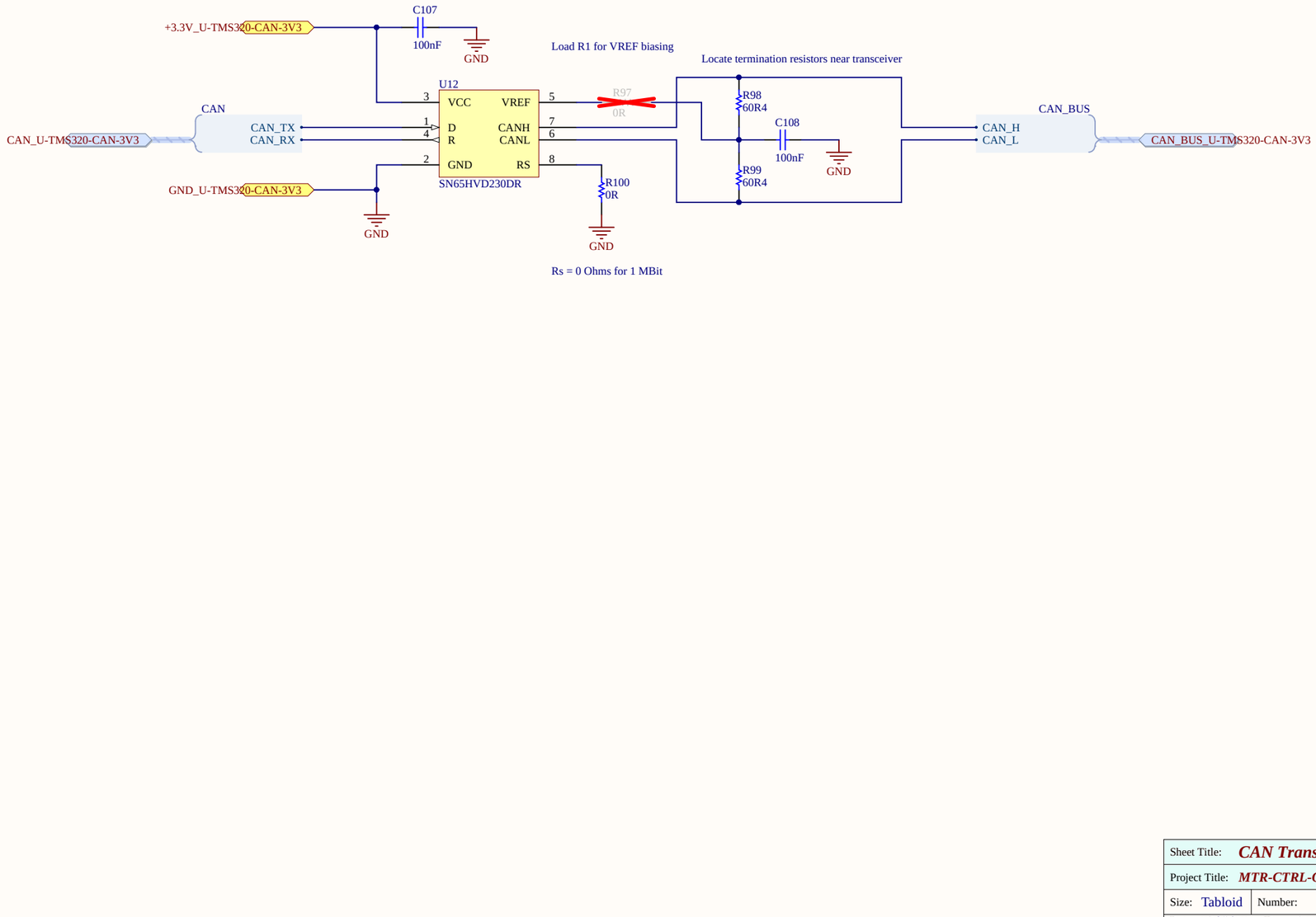


Rs = 0 Ohms for 1 MBit

Sheet Title: *CAN Transceiver*		**Makani Project**
Project Title: *MTR-CTRL-OZONE-MAIN.PrjPcb*		*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number: / Revision:	
Date: 7/18/2017 Time: 2:55:32 PM	Sheet * of 33	
Author: EAC	File: MMS-0001-00021-A.5.SchDoc	



Sheet Title:	***CAN Transceiver***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:33 PM	Sheet * of 33	
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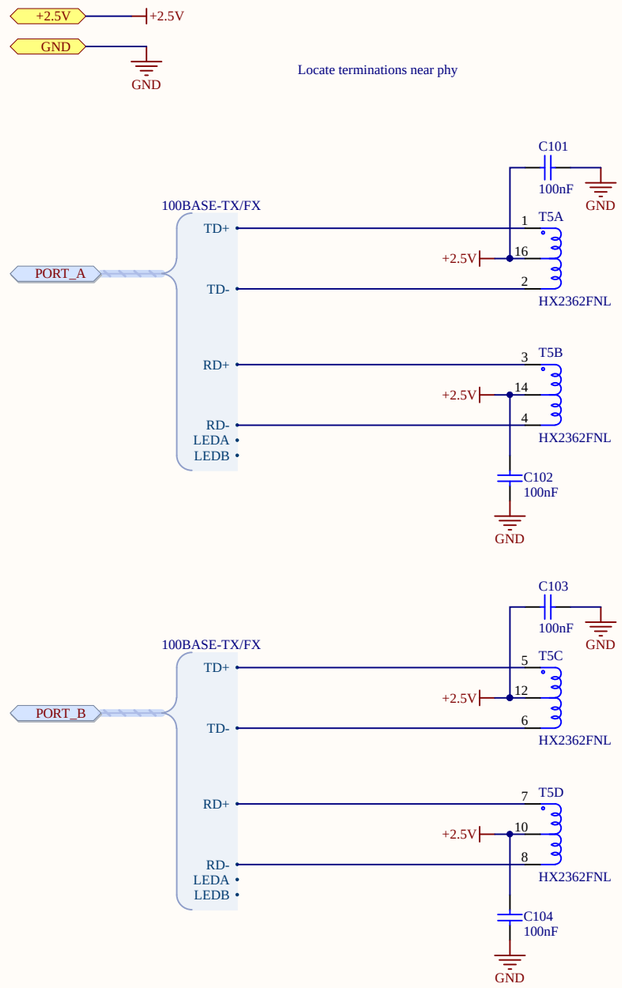

Sheet Title:	***Dual BCM Termination***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:33 PM	Sheet * of 33	
Author: eac	File: MMS-0001-00025-A.4.SchDoc		

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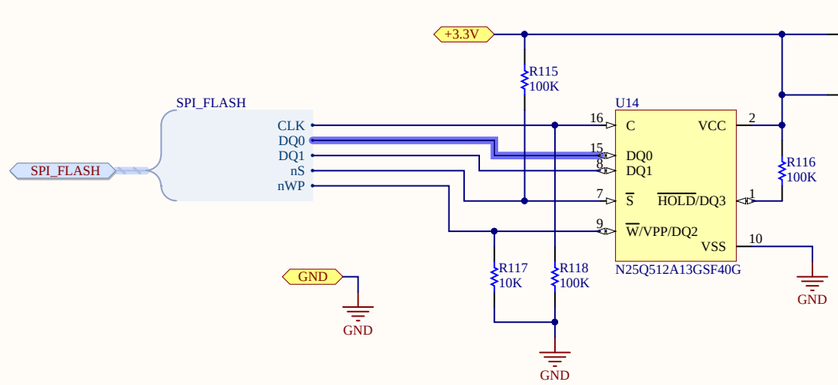

Sheet Title:	***SPI NOR Flash***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:33 PM	Sheet * of 33	
Author: EAC	File: MMS-0001-00034-A.3.SchDoc		

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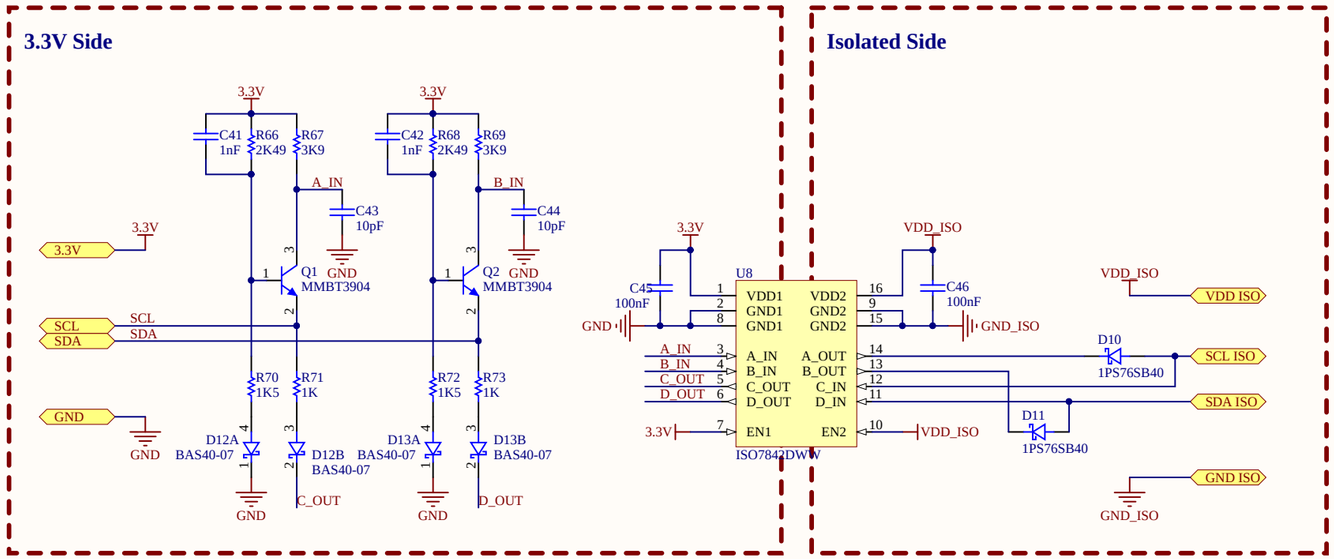

Bidirectional isolated I2C interface (external 4.7kOhm I2C pullup resistor required)

Function:
2828Vdc isolated I2C interface with bidirectional I2C bus
Input: (3.3V side, I2C master)

3.3V	3.3V power
GND	Ground of 3.3V power
SCL	I2C bus clock input on 3.3V logic side, bidirectional
SDA	I2C bus data I/O on 3.3V logic side, bidirectional

Output: (VDD_ISO side)

VCC_ISO	DC power of output side, 2.5V to 5V
GND_ISO	Ground of output side
SCL_ISO	I2C bus clock output on VCC2 side, bidirectional
SDA_ISO	I2C bus data I/O on VCC2 side, bidirectional

Specification:

Isolation	
Viowm	2828Vdc (working voltage)
Viotm	8000Vpk
Viso	5700Vrms (UL 1577 1minutes)
Input voltage	3.3V
Ouput voltage	2.5-5V

Comments:
1. C3, C5(1nF) is optional. It can reduce propagation delay by increase the charge injection into Q1's base
2. C4, C6 (10pF) is optional. It is used to avoid false triggering of the isolator
3. R2/R7, R3/R6, R4/R5, adn R1/R8 are optimized for 3.3V input and 4.7kOhm bus pull up resistor.
4. VCC2 side pull up resistor can be other value

Sheet Title:	***5700V I2C Isolator Bidirectional***		
Project Title:	***MTR-CTRL-OZONE-MAIN.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:33 PM	Sheet * of 33	
Author: TT	File: MMS-0001-00043-A.11.SchDoc		

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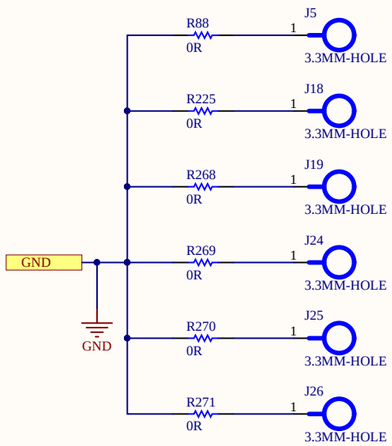

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Project Title: ***MTR-CTRL-OZONE-MAIN.PrjPcb***			* * * *
Size: Tabloid	Number:	Revision:	
Date: 7/18/2017	Time: 2:55:33 PM	Sheet * of 33	
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