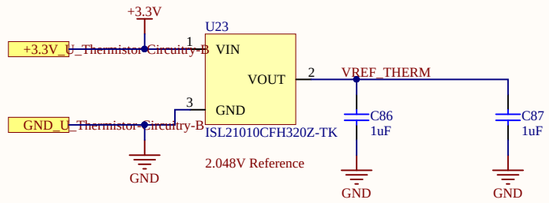
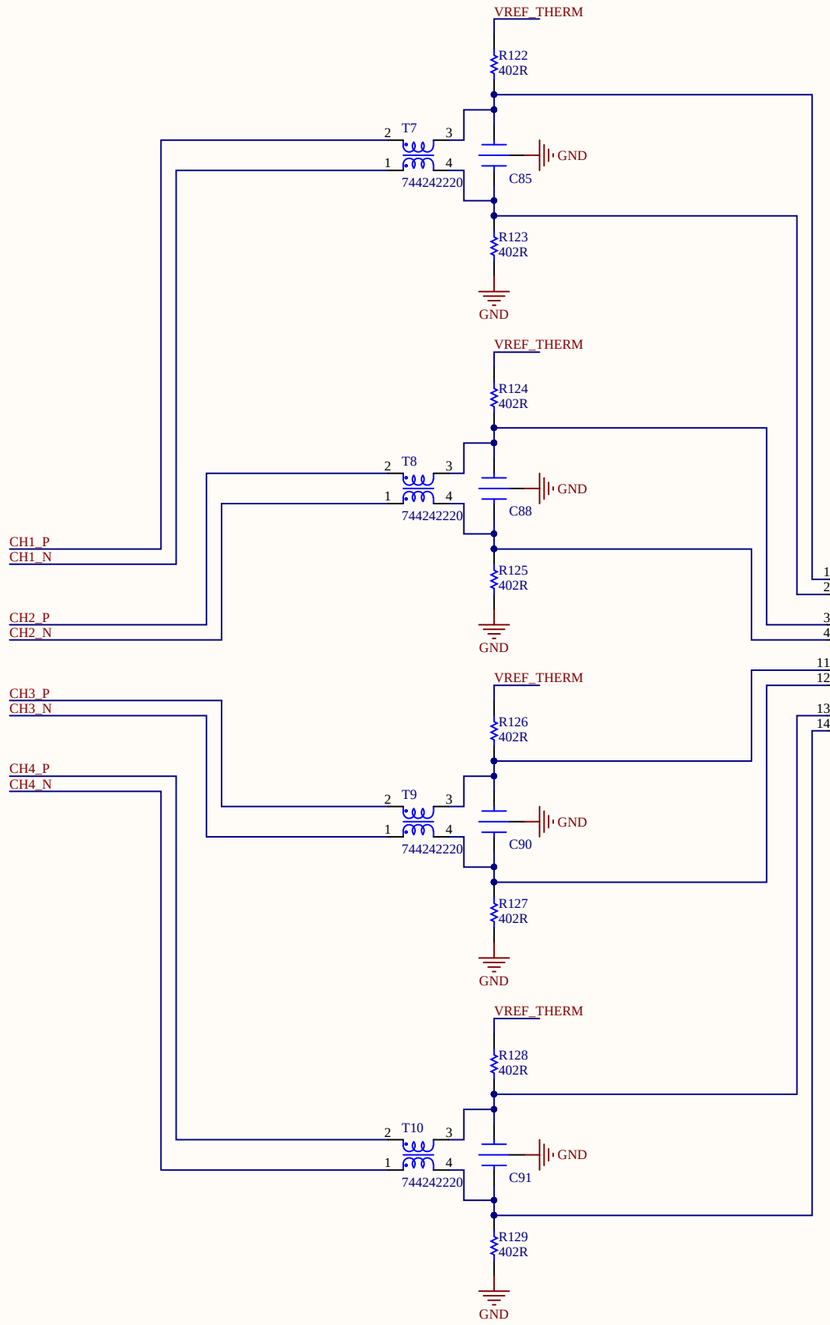
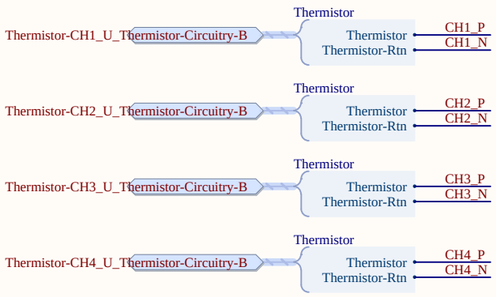
Thermistor Circuitry







Sheet Title:	***Thermistor-Circuitry***	
Project Title:	***SynchronousRectifier.PrjPcb***	
Size: Tabloid	Number:	Revision:
Date: 10/21/2019	Time: 10:48:55 AM	Sheet .2 of 17
Author: *	File: Thermistor-Circuitry.SchDoc	

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA

Synchronous Rectifier (SMD)

U_Synchronous-Rectifier-SMD
Synchronous-Rectifier.SchDoc

+12V
GND
LV-Rect
LV-Rect-Rtn
Pos_Trigger
Neg_Trigger
Thermistor
Thermistor-CH3

LV Filter

U_LV-Filter
LV-Filterr.SchDoc

LV-Rect
LV-Rect-Rtn
LV
Thermistor
GND
E17
5015
Thermistor-CH2

Output Connection Switch (BMB)

U_Output-Connection-Switch
Battery-Connection-Switch.SchDoc

LV
OUTPUT_SWITCH_MID
VIN
SWITCH_MID
GND
VOUT
Thermistor
SWEN1
SWEN2
LV_Out
Thermistor-CH1
Output_sw1
Output_sw0

Hall Effect Sensor (BMB)

U_Hall-Effect-Current-Sensor
Hall-Effect-Current-Sensor.SchDoc

IP+
IP-
+3.3V
GND
OUTPUT
SUPPLY_DIV2
LV_PRI
HALL_OUTPUT_MON
HALL_SUPPLY_MON
E18
5015
E19

Minimum Load

Extension Connectors

U_Extension-Connector
Extension_Connector.SchDoc

+12V
3.3V-local
LV
LV_OR
LV_PRI
LV_SEC
GND
12V
+3.3V
ADC
AGND
I2C
DGND
MV_Trig_LS
MV_Trig_HS
LVUV
Disable
Thermistor-CH1
Thermistor-CH2
Thermistor-CH3
Thermistor-CH4
Thermistor-CH5
Thermistor-CH6
Thermistor-CH7
Thermistor-CH8
ADC_OUT
I2C
I2C_SCL
I2C_SDA

SR Controller

U_SyncRectController
SyncRectController.SchDoc

MV_Trig_LS
MV_Trig_HS
LVUV
Disable
N2HET1_14
N2HET1_16
N2HET1_18
N2HET1_20
N2HET1_PIN_nDIS
AIO_Disable
AIO_OutputSw0
AIO_OutputSw1
AIO_DIO0
AIO_DIO1
Output_sw0
Output_sw1
Pos_Trigger
Neg_Trigger
LV
+3.3V
12V
GND
3.3V-local
+12V

LV Summing and Monitor

U_Power_LV_Input
Power_LV_Input.SchDoc

LV
LV_SEC
LV_PRI
+5V
+12V
GND
LV_OR
LV_MON
LV_PRI_MON
LV_SEC_MON
LV_OR_MON
+12V_MON
+5V_MON

LV-12V (BMB)

U_Power_12V
Power_12V.SchDoc

LV_OR
+12V_DISABLE
GND
+12V
+5V

Serialization EEPROM

I2C address: 1010XXX (gets entire address space)
U_MMS-I2C-EEPROM
MMS-0001-00040-A.5.SchDoc

I2C
EEPROM_WP
WP
+3.3V
GND

MRAM Logger

U_Mram-Logger
Mram-Logger.SchDoc

+3.3V
GND
SPI
WP
HOLD
GIOA7
N2HET1_4
SPI_CLK
SPI_MOSI
SPI_MISO
SPI_NCS0
SPI_NCS1
SPI3_CLK
SPI3_MOSI
SPI3_MISO
SPI3_NCS0

On board Thermistor Circuitry

I2C address: 1101000
U_Thermistor-Circuitry-A
Thermistor-Circuitry.SchDoc

+3.3V
GND
SDA
SCL
ADR0
ADR1
Thermistor-CH1
Thermistor-CH2
Thermistor-CH3
Thermistor-CH4
I2C_SDA
I2C_SCL
E20
5016

Off board Thermistor Circuitry

I2C address: 1101001
U_Thermistor-Circuitry-B
Thermistor-Circuitry.SchDoc

Thermistor-CH5
Thermistor-CH6
Thermistor-CH7
Thermistor-CH8

AIO Node Interface

U_MMS-AIO-Module-Interface
MMS-0001-00035-A.11.SchDoc

J22
CONN
1 CAN1_TX
2 CAN1_RX
43650-0217
CAN
CAN_TX
CAN_RX
CAN1
AIO_GTI
SPI1_NCS4
GPIO
N2HET1
CAN2
CAN3
SPI3
SCI
LIN
PORT4
+12V_AIO
+12V_CARRIER
+3.3V
+2.5V
+1.2V
CARRIER_ID
I2C
ADC
AGND
GND
+12V
+3.3V
+2.5V
+1.2V

GPIO_TMS
GIOA2
GIOA6
GIOA7

N2HET1
N2HET1_22
N2HET1_4
N2HET1_14
N2HET1_16
N2HET1_18
N2HET1_20
N2HET1_PIN_nDIS

SPI3_TMS
SPI3_CLK
SPI3_MOSI
SPI3_MISO
SPI3_NCS0
SPI3_NCS1
SPI3_NCS4
SPI3_NCS5

CARRIER_ID
CARRIER_ID0
CARRIER_ID1
CARRIER_ID2
CARRIER_ID3

I2C
I2C_SCL
I2C_SDA

TMS_ADC_14_23
ADC14
ADC15
ADC16
ADC17
ADC18
ADC19
ADC20
ADC21
ADC22
ADC23
+5V_MON
ADC_OUT
LV_PRI_MON
HALL_SUPPLY_MON
LV_OR_MON
HALL_OUTPUT_MON
LV_SEC_MON
LV_MON
+12V_MON
EEPROM_WP

BOARD_ID = 1001 (HV-LV converter)

The AIO module standoff height should be 0.250 inches (6.35 mm).

M3 chassis mount holes should be used for non-captured hardware.

SMTSO-632-8ET PemNuts have 6-32 thread for direct mounting (but uses non-metric screws).

SMTSO-143-8ET PemNuts have clearance holes for use with an M3 stacked standoff on the bottom.

AIO Board Mounting

J15
J16
J17
J18
SMTSO-116-8ET
R118
R119
R120
R121
0R

SR Board Mounting

J9
J10
J11
J12
J13
J14
M3-CHASSIS-MOUNT
R112
R113
R114
R115
R116
R117
0R

PCB Temperature

R111
Thermistor
CH4_P
CH4_N
Thermistor
Thermistor-Rtn
Thermistor-CH4

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

Sheet Title:	*MV-LV SR Top Level Design*
Project Title:	*SynchronousRectifier.PrjPcb*
Size: Tabloid	Number: / Revision:
Date: 10/21/2019	Time: 10:48:56 AM / Sheet 1 of 17
Author: TT	File: Top Level.SchDoc

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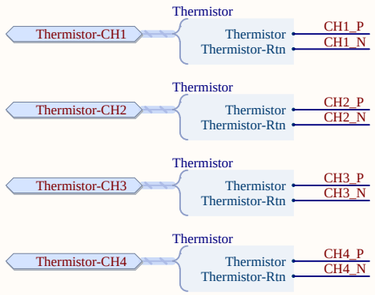
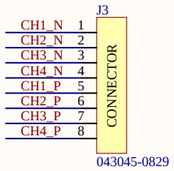
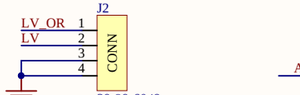
USA

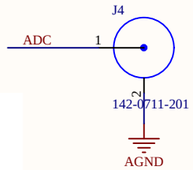




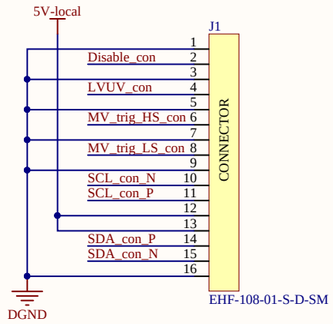
IGBT Controller connector (LV)

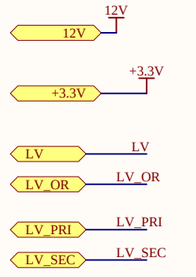


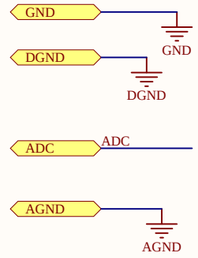
1: LV_OR to power IGBT controller
2: LV for LV sense
3: LV return for LV_OR
4: LV return for LV sensing

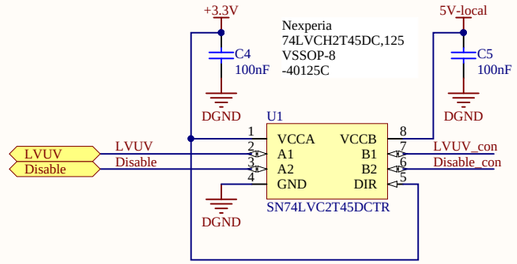


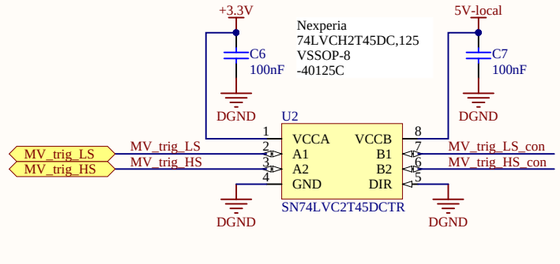
IGBT Controller connector (signal)



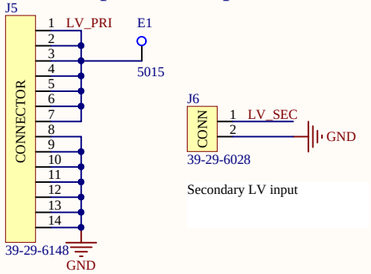




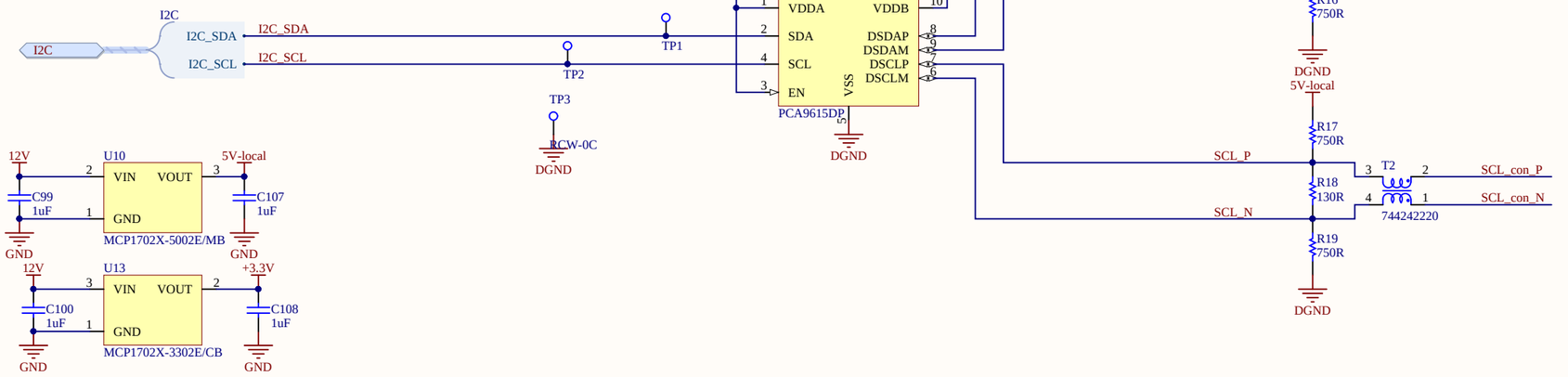




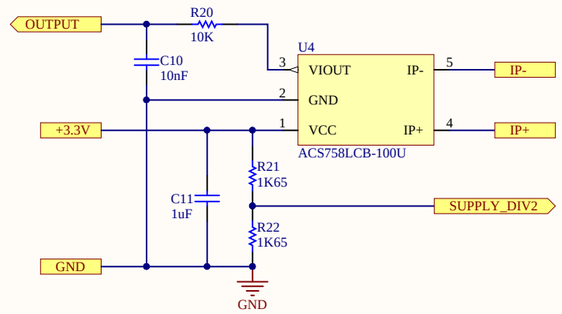
LV input and output



Secondary LV input



Sheet Title: *			*
Project Title: *SynchronousRectifier.PrjPcb*			*
Size: Tabloid	Number:	Revision:	*
Date: 10/21/2019	Time: 10:48:56 AM	Sheet 2 of 17	*
Author: *	File: Extension_Connector.SchDoc		

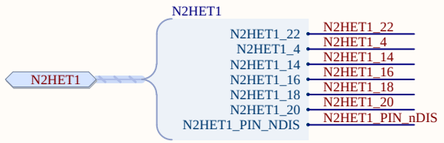


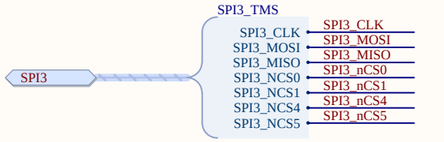
AIO filter: 51 Ohm 1nF, f0 =3.12MHz

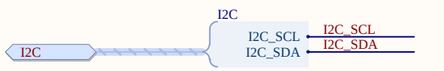
10 kOhm 10nF, f0 =1.59kHz

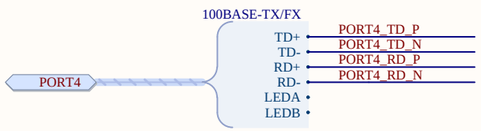
Hall Effect Sensor

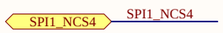
Sheet Title: *Hall-Effect-Current-Sensor*			**Makani Project**
Project Title: *SynchronousRectifier.PrjPcb*			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 10/21/2019 Time: 10:48:56 AM	Sheet 6 of 17		*Alameda CA, 94501*
Author: *	File: Hall-Effect-Current-Sensor.SchDoc		*USA*

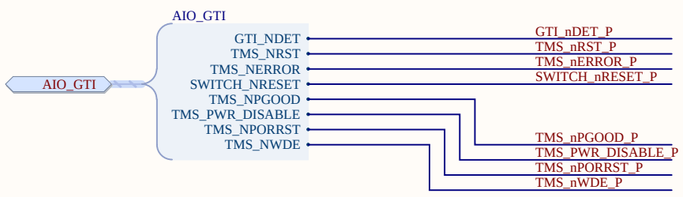


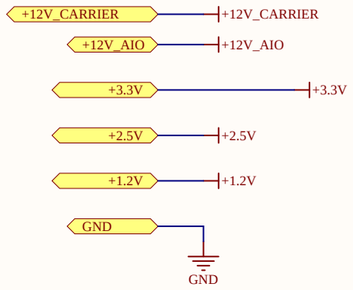


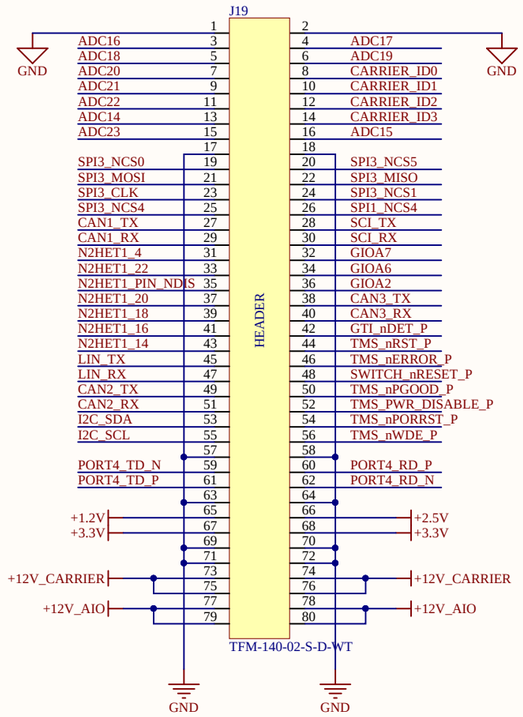


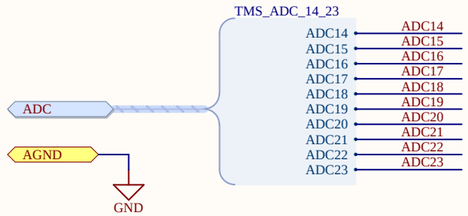












CARRIER_ID encodes the type of carrier board.
Pins should be grounded (0) or left floating (1).
No carrier board = 1111

NOTES ON POWER

+1.2V: For monitoring only.
+2.5V: For PORT4 ethernet bias and monitoring only.
+3.3V: Limit current to 250 mA (needs verification).
+12V_CARRIER: Supplied by the carrier board to the AIO board.
+12V_AIO: Supplied by the AIO board to the carrier board.

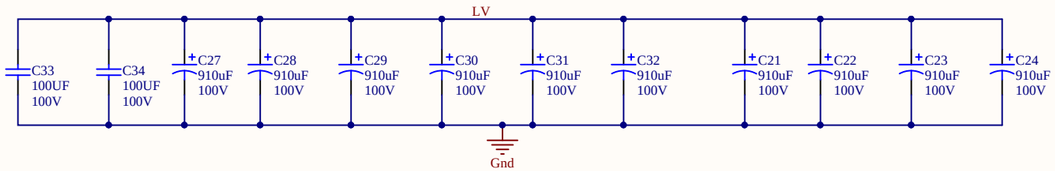
Sheet Title: *AIO Module Interface*		**Makani Project**
Project Title: *SynchronousRectifier.PrjPcb*		*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 10/21/2019 Time: 10:48:56 AM	Sheet 7 of 17	*Alameda CA, 94501*
Author: EAC	File: MMS-0001-00035-A.11.SchDoc	*USA*

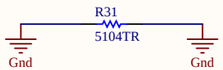
Film Cap 1(R60EW61005000K)
100uF 100V, 37.5mm, 41.50mm x 20.00mm x 41mm, -55°C ~ 105°C, PE&PET, $12.57

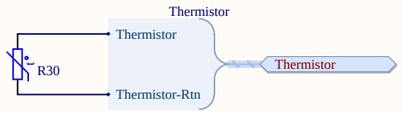
Film Cap 2 (B32526R3686K) CMP-0174-00328-1
68uF 250V, 37.5mm, 28.0mm x 42.5mm x 41.5mm, -55°C ~ 125°C, PE&PET, $21.03

Film Cap 3(C4ATDBW5600A30J) CMP-0192-00004-2
60uF 250V, 52.5mm, 57.50mm x 35.00mm x 50mm, -40°C ~ 85°C, PP, $11.17

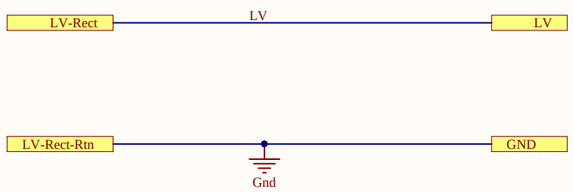
Al Cap (EGPD101ELL911MM40H)
910uF 100V, 7.5mm, 18.0mm x 41.5mm, 2000 Hrs @ 135°C, $4.51







EIA1206 NTC Thermistor



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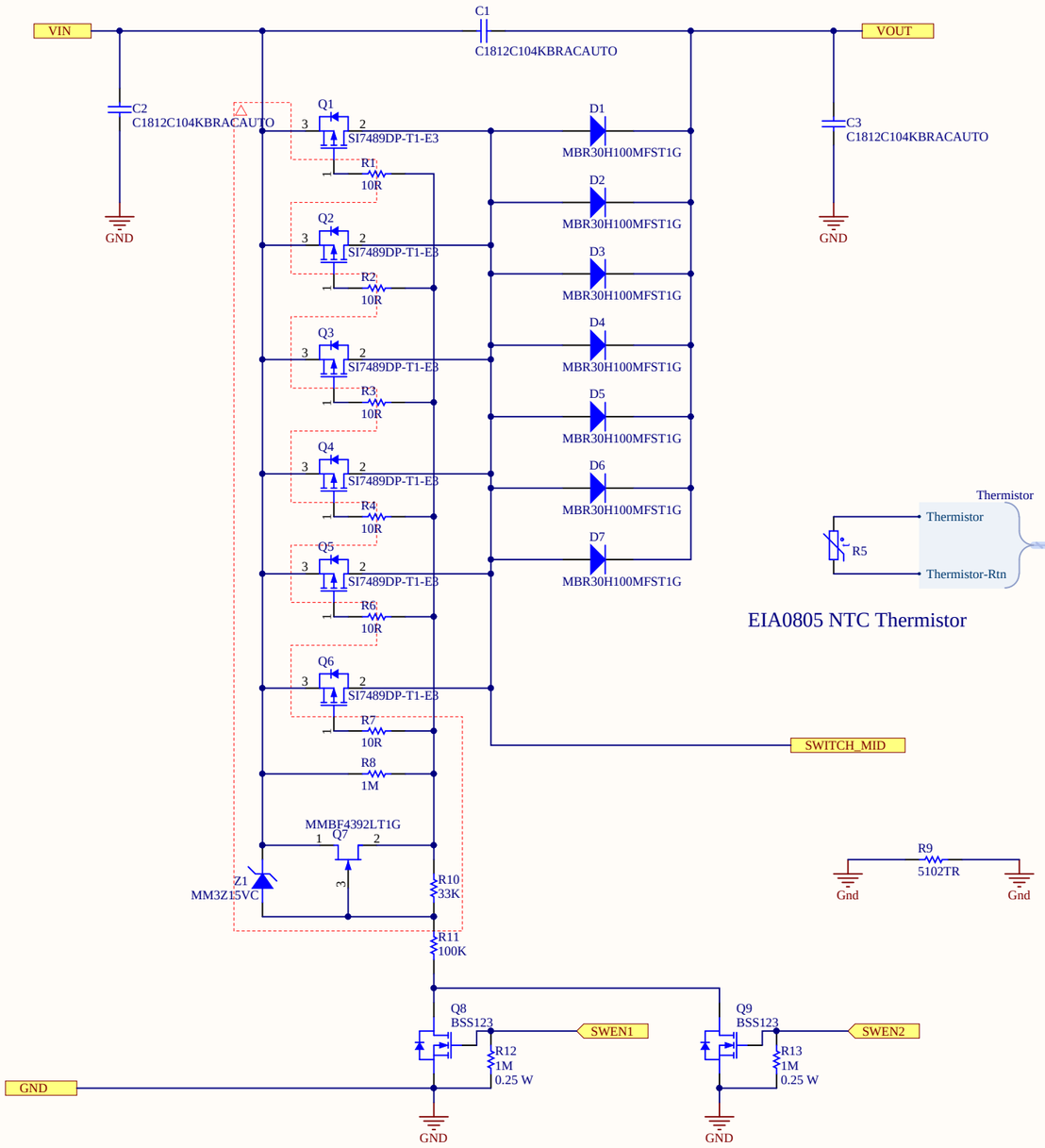
Project Title: *SynchronousRectifier.PrjPcb*			* * * *
Size: Tabloid	Number:	Revision:	
Date: 10/21/2019 Time: 10:48:56 AM	Sheet 7 of 17		
Author: *	File: LV-Filterr.SchDoc		

Battery Connection Switch



EIA0805 NTC Thermistor

Sheet Title:	***Battery-Connection-Switch***		
Project Title:	***SynchronousRectifier.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 10/21/2019	Time: 10:48:56 AM	Sheet 10 of 17	
Author: *	File: Battery-Connection-Switch.SchDoc		

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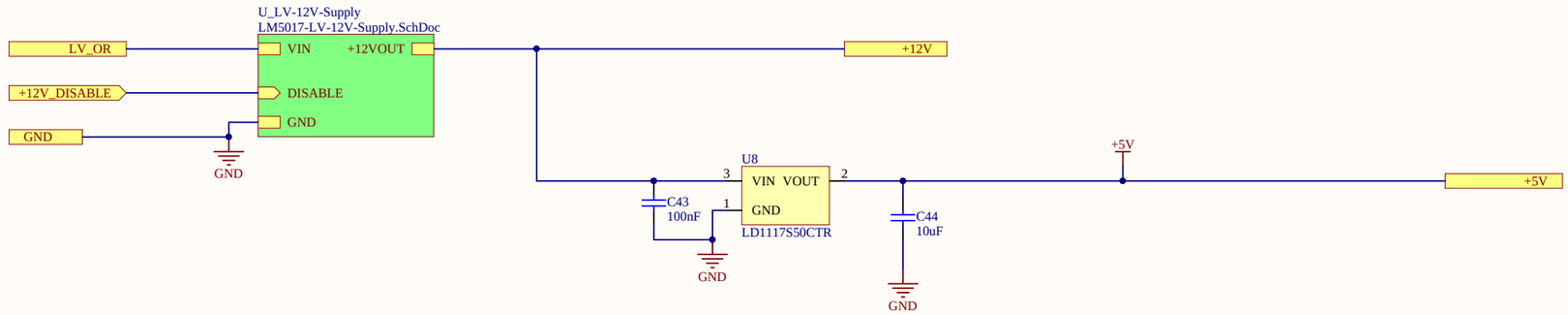
Alameda CA, 94501
USA



Sheet Title:	***Power_12V***		
Project Title:	***SynchronousRectifier.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 10/21/2019	Time: 10:48:56 AM	Sheet 11 of 17	
Author: *	File: Power_12V.SchDoc		

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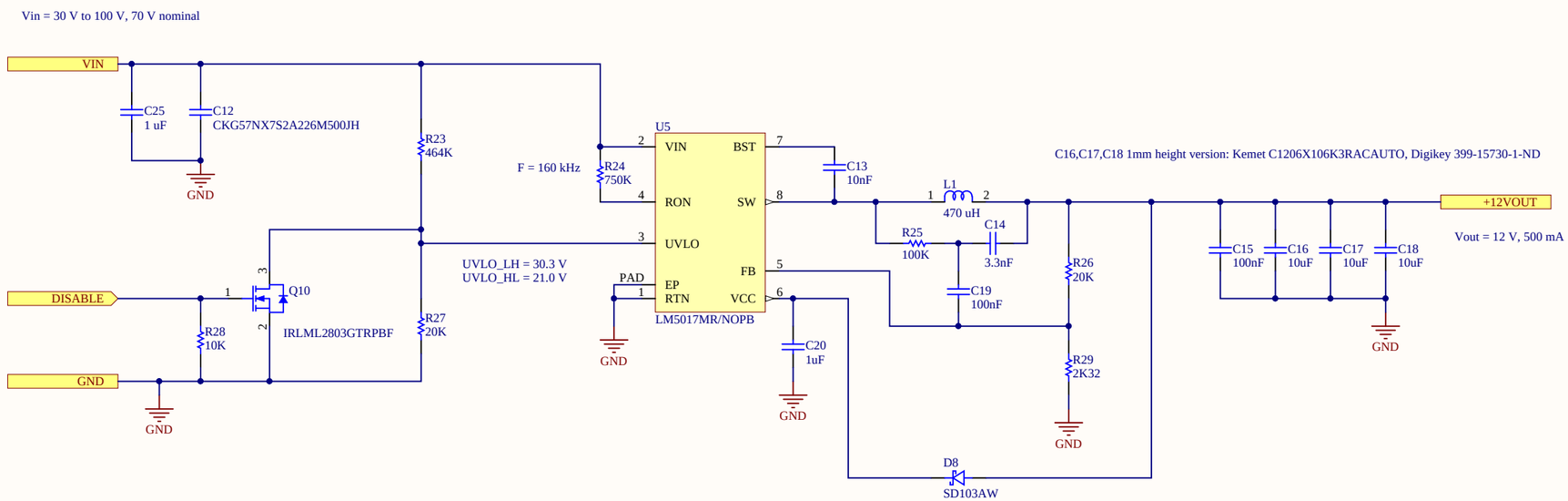
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA



Sheet Title: *LM5017-LV-12V-Supply*			**Makani Project**
Project Title: *SynchronousRectifier.PrjPcb*			*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
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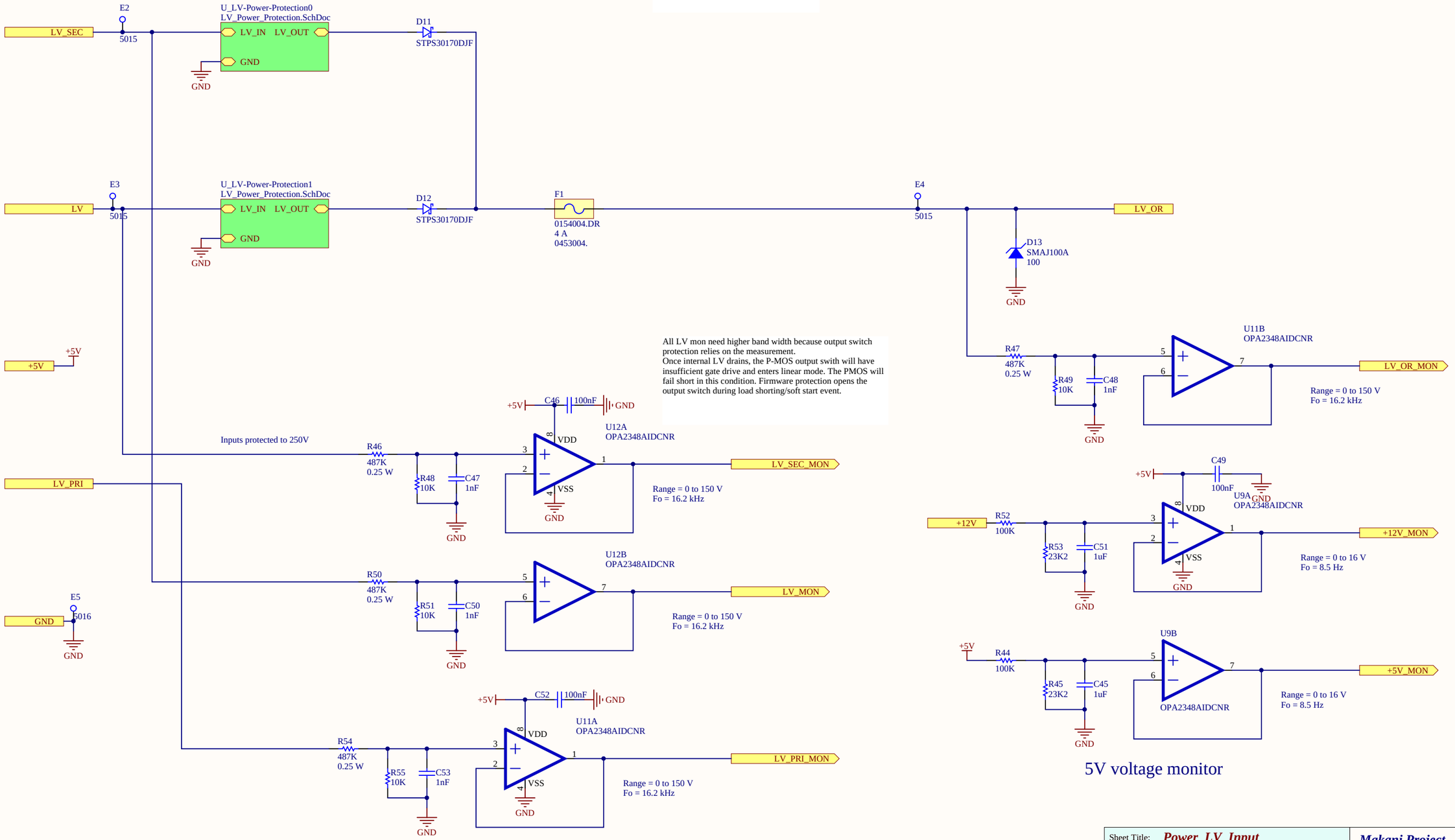
Author: *	File: LM5017-LV-12V-Supply.SchDoc		

Power LV input:
Modified based on
BMB-AIO-Carrier version AB

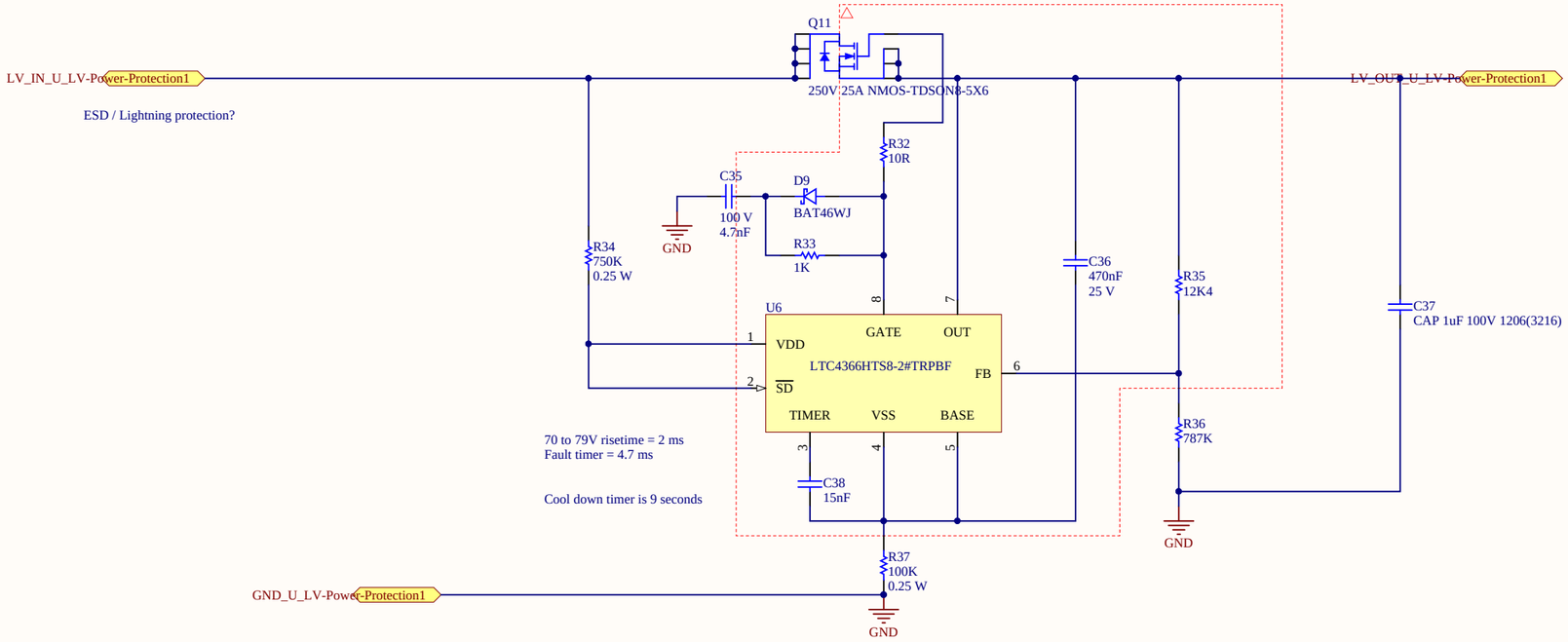


5V voltage monitor

Sheet Title: *Power_LV_Input*		**Makani Project**
Project Title: *SynchronousRectifier.PrjPcb*		*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number: / Revision:	
Date: 10/21/2019 Time: 10:48:56 AM	Sheet 13 of 17	
Author: TT	File: Power_LV_Input.SchDoc	

Maximum transient overvoltage = 200 V
Maximum continuous voltage = 87.5 V
Minimum voltage = 31 V

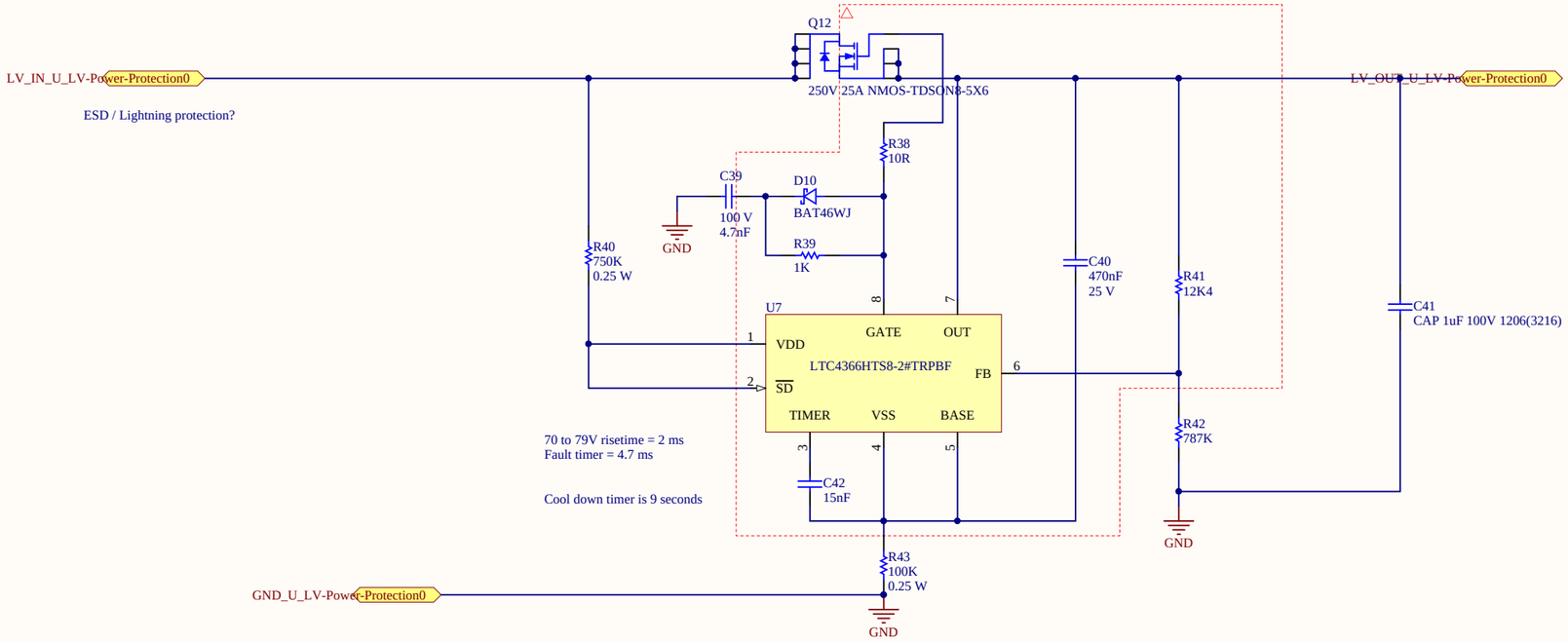
Output clamp voltage = 89.2 V (min = 87.5 V, max = 91.0 V)



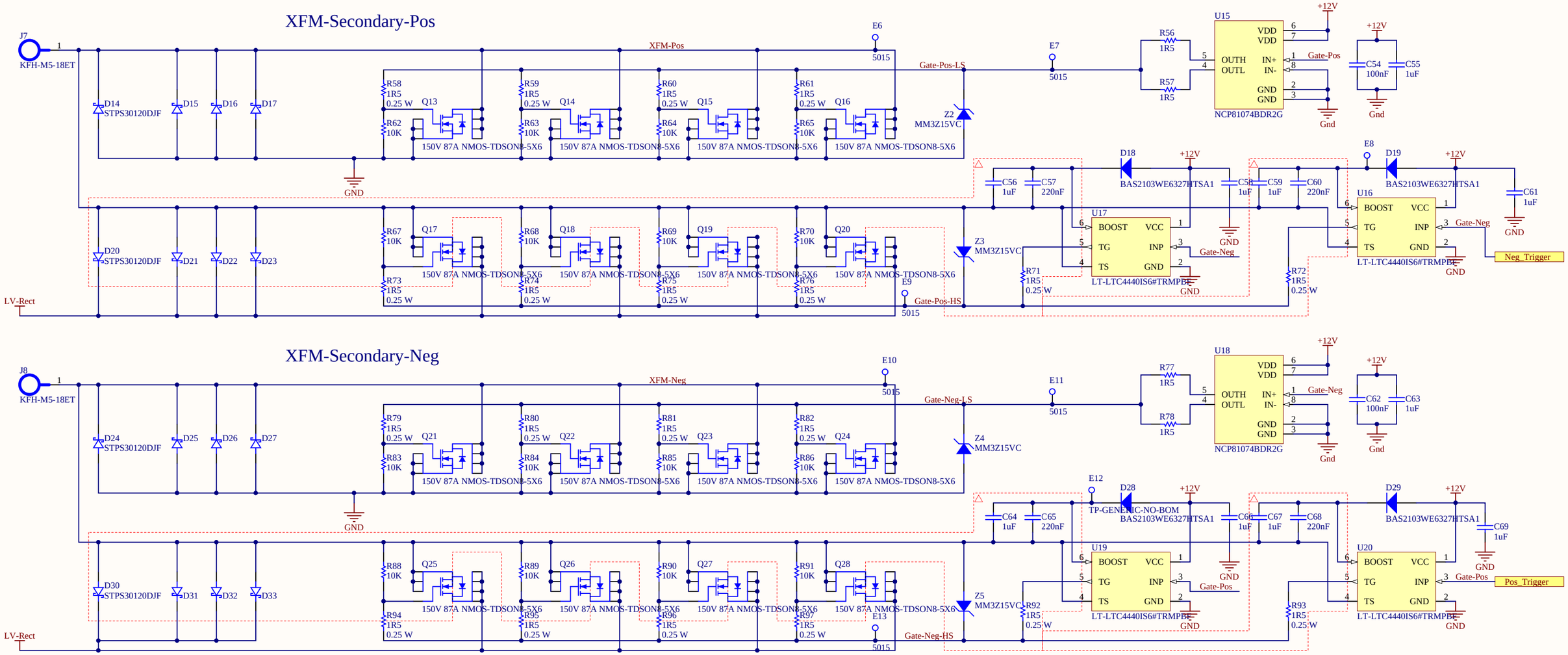
Sheet Title: *			**Makani Project**
Project Title: ***SynchronousRectifier.PrjPcb***			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 10/21/2019	Time: 10:48:57 AM	Sheet 14 of 17	*Alameda CA, 94501*
Author: *	File: LV_Power_Protection.SchDoc		*USA*

Maximum transient overvoltage = 200 V
Maximum continuous voltage = 87.5 V
Minimum voltage = 31 V

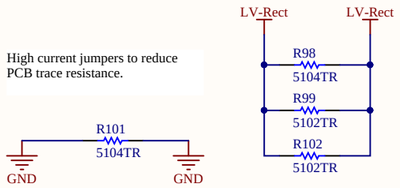
Output clamp voltage = 89.2 V (min = 87.5 V, max = 91.0 V)

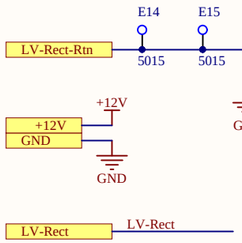


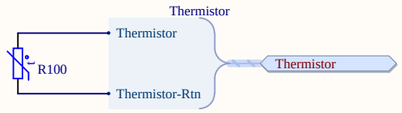
Sheet Title: *			**Makani Project**
Project Title: ***SynchronousRectifier.PrjPcb***			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 10/21/2019	Time: 10:48:57 AM	Sheet 15 of 17	*Alameda CA, 94501*
Author: *	File: LV_Power_Protection.SchDoc		*USA*



High current jumpers to reduce PCB trace resistance.



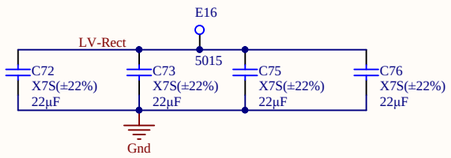




EIA1206 NTC Thermistor

Ceramic Cap (CKG57NX7S2A226M500JH)
22uF 100V, X7S, EIA2220, 6.00mm x 5.00mm x 5.50mm, -55°C ~ 125°C, $4.64

Ceramic Cap (CKG57NX7R2A106M500JJ)
10uF 100V, X7R, EIA2220, 6.00mm x 5.00mm x 5.50mm, -55°C ~ 125°C, $6.53



MOSFET in the design can be replaced by diode (STPS30120DJF) since they have the same footprint.
In order to do that, DNP all gate resistors and make the gate pad floating.

MOSFET:
BSC035N10NS5ATMA1
Diode:
STPS30120DJF

High side gate driver:
IRS10752/20752
LTC4440

Sheet Title:	***MV-LV Sync Rectifier***		
Project Title:	***SynchronousRectifier.PrjPcb***		
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Author: TT	File: Synchronous-Rectifier.SchDoc		

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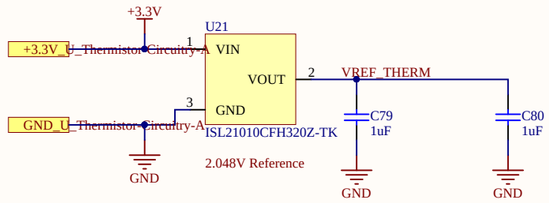
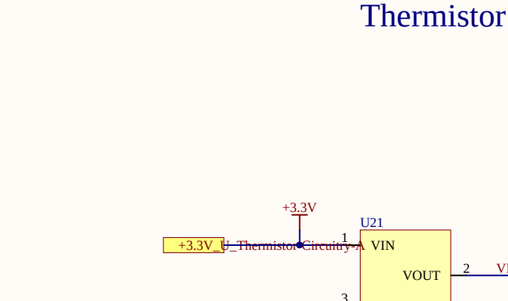
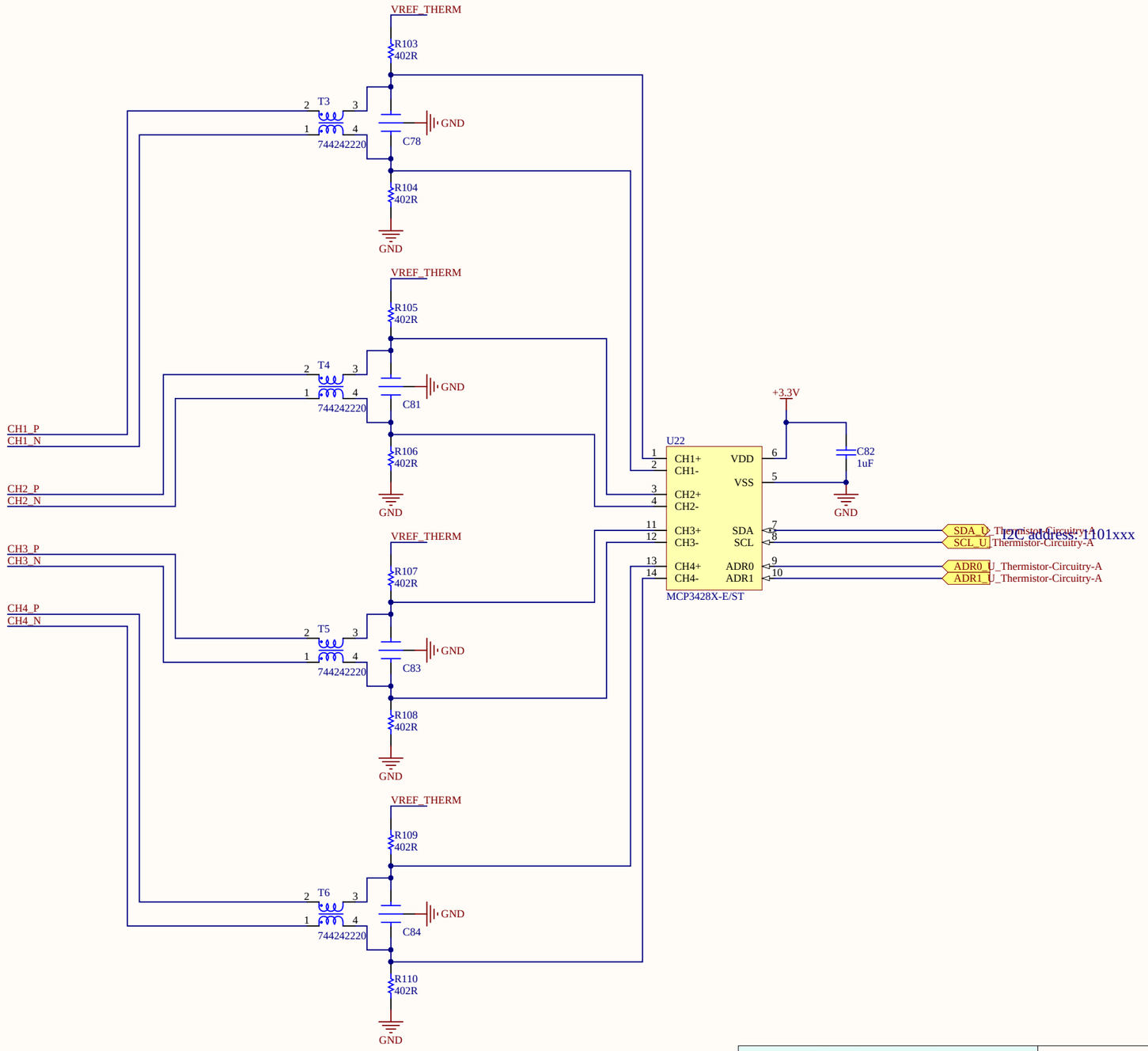
Thermistor Circuitry







Sheet Title:	***Thermistor-Circuitry***		
Project Title:	***SynchronousRectifier.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 10/21/2019	Time: 10:48:57 AM	Sheet 20 of 17	
Author: *	File: Thermistor-Circuitry.SchDoc		

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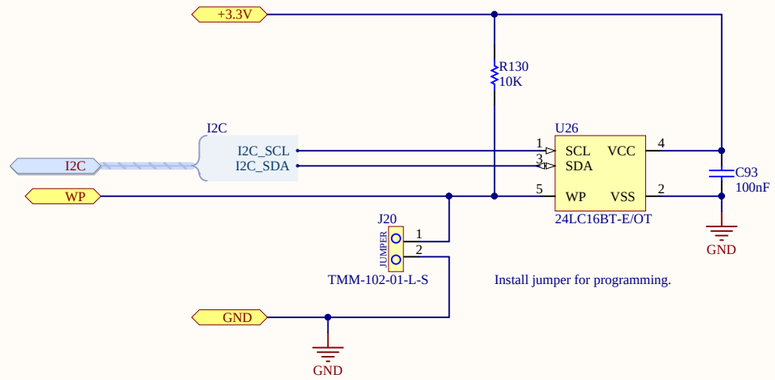

Sheet Title:	***I2C EEPROM***		
Project Title:	***SynchronousRectifier.PrjPcb***		
Size: Tabloid	Number:	Revision:	
Date: 10/21/2019	Time: 10:48:57 AM	Sheet * of 17	
Author: EAC	File: MMS-0001-00040-A.5.SchDoc		

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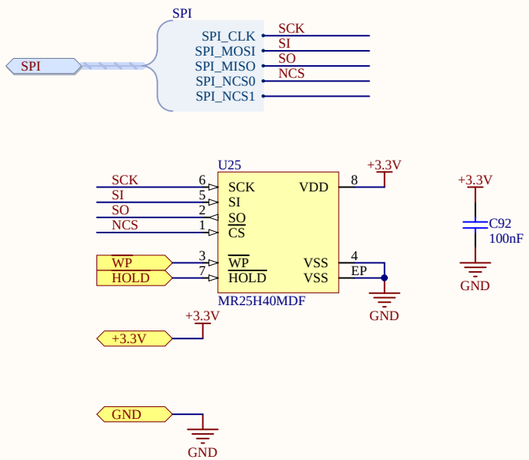

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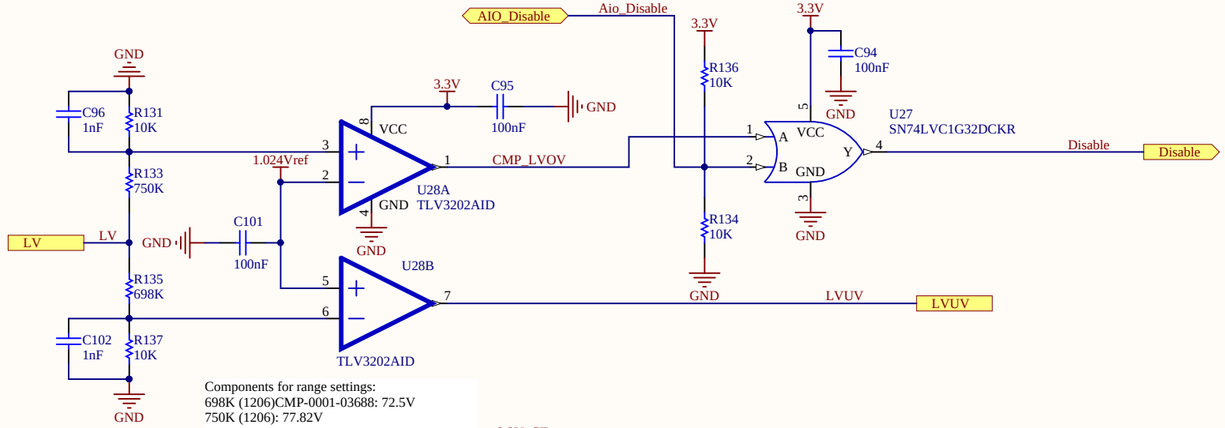
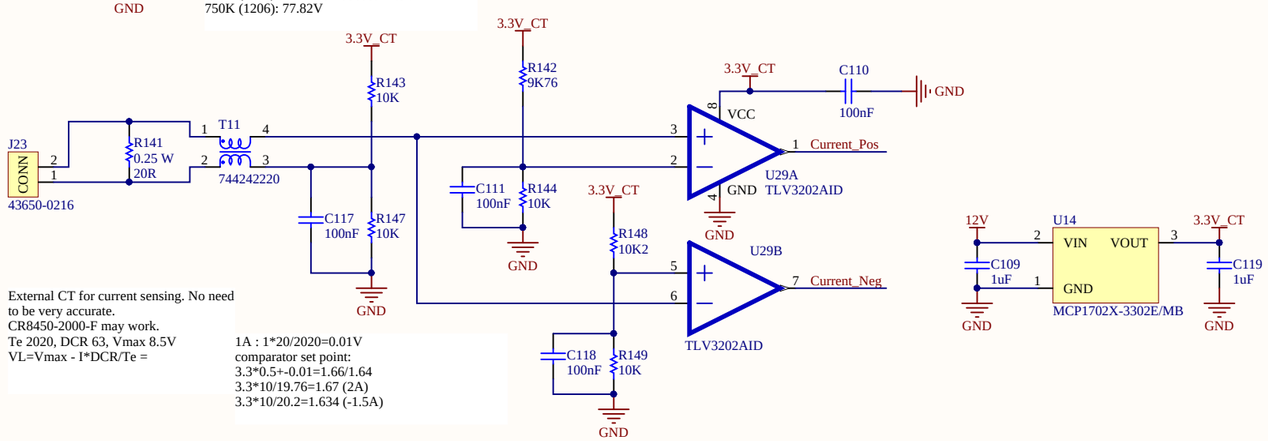
Project Title: *SynchronousRectifier.PrjPcb*			*
Size: Tabloid	Number:	Revision:	*
Date: 10/21/2019 Time: 10:48:58 AM	Sheet * of 17		*
Author: *	File: Mram-Logger.SchDoc		*

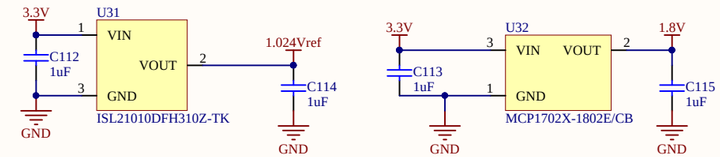


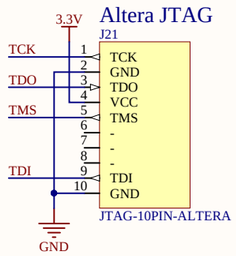
Components for range settings:
698K (1206)CMP-0001-03688: 72.5V
750K (1206): 77.82V



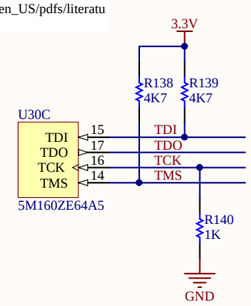
External CT for current sensing. No need to be very accurate.
CR8450-2000-F may work.
Te 2020, DCR 63, Vmax 8.5V
VL=Vmax - I*DCR/Te =

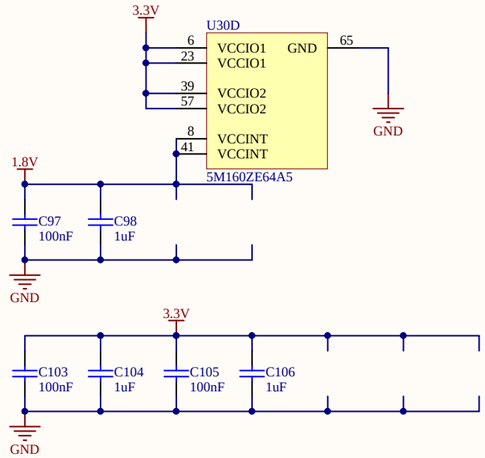
1A : 1*20/2020=0.01V
comparator set point:
3.3*0.5+-0.01=1.66/1.64
3.3*10/19.76=1.67 (2A)
3.3*10/20.2=1.634 (-1.5A)

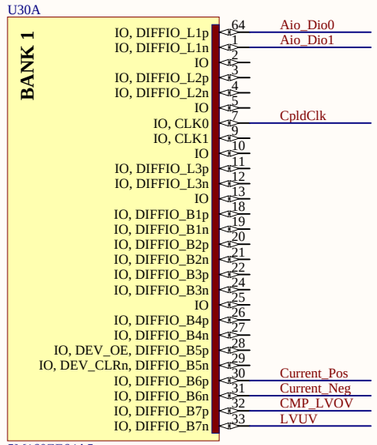


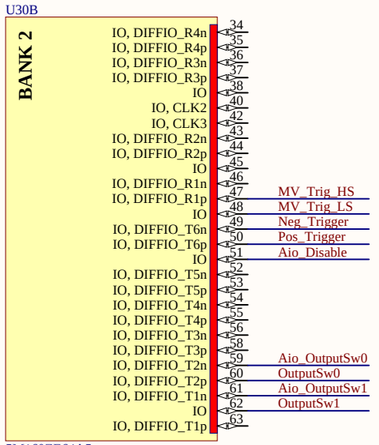


https://www.altera.com/en_US/pdfs/literature/ug/ug_usb_blstr.pdf

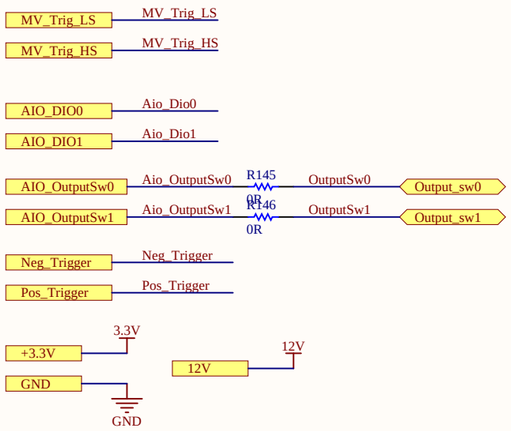


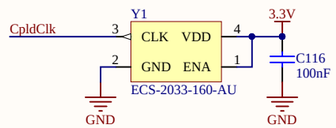






LVUV: from compatator to CPLD/AIO to measure trigger frequency or regulation
LVOV: over voltage shut off.





Sheet Title: *		*
Project Title: *SynchronousRectifier.PrjPcb*		
Size: Tabloid	Number:	Revision:
Date: 10/21/2019 Time: 10:48:58 AM	Sheet * of 17	
Author: *	File: SyncRectController.SchDoc	