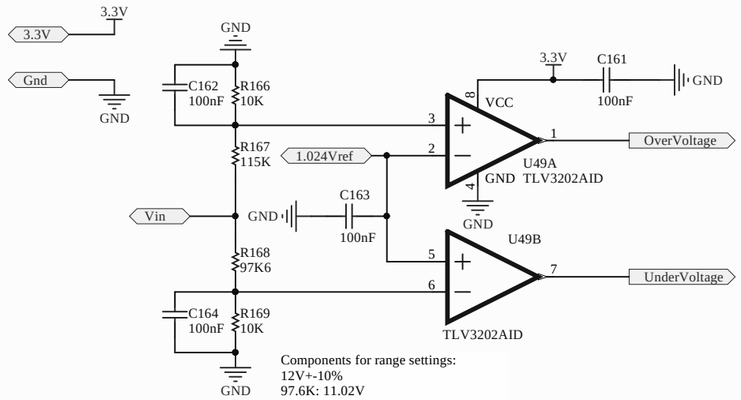
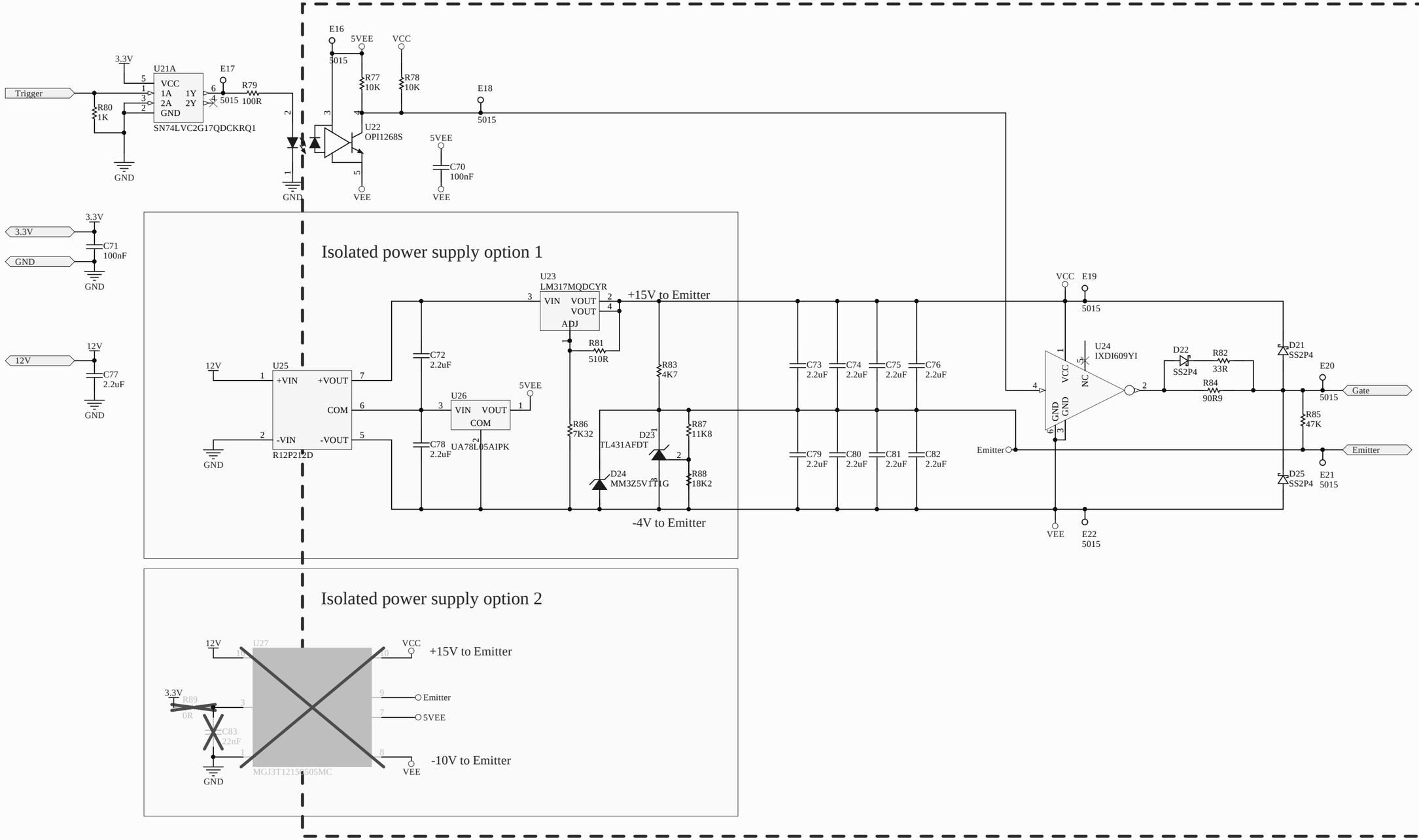


Components for range settings:
12V+-10%
97.6K: 11.02V
115k: 12.8V
698K (1206)CMP-0001-03688: 72.5V

124K: 13.72V
91K: 10.34V

Bandwidth: 1/(10k*C*2*pi)
1nF: 15.9kHz

Sheet Title: *			*
Project Title: ***IgbtControl.PrjPcb***			* * * *
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:13 PM	Sheet * of *	
Author: *	File: Window_Comparator.SchDoc		



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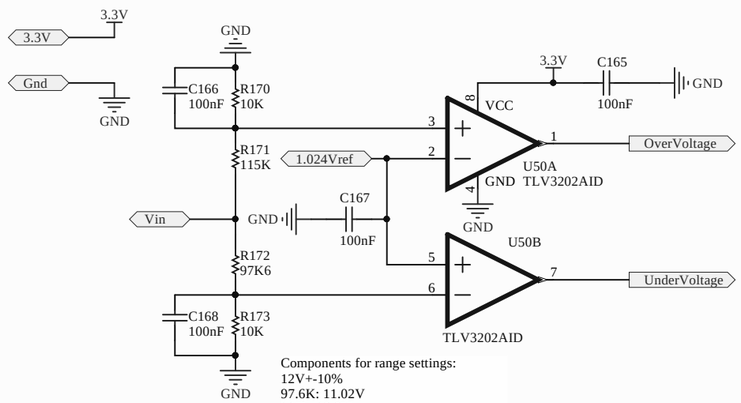
Project Title: ***IgbtControl.PrjPcb***			
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:13 PM	Sheet * of *	
Author: *	File: Isolated_Gate_Drive.SchDoc		



Components for range settings:
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115k: 12.8V
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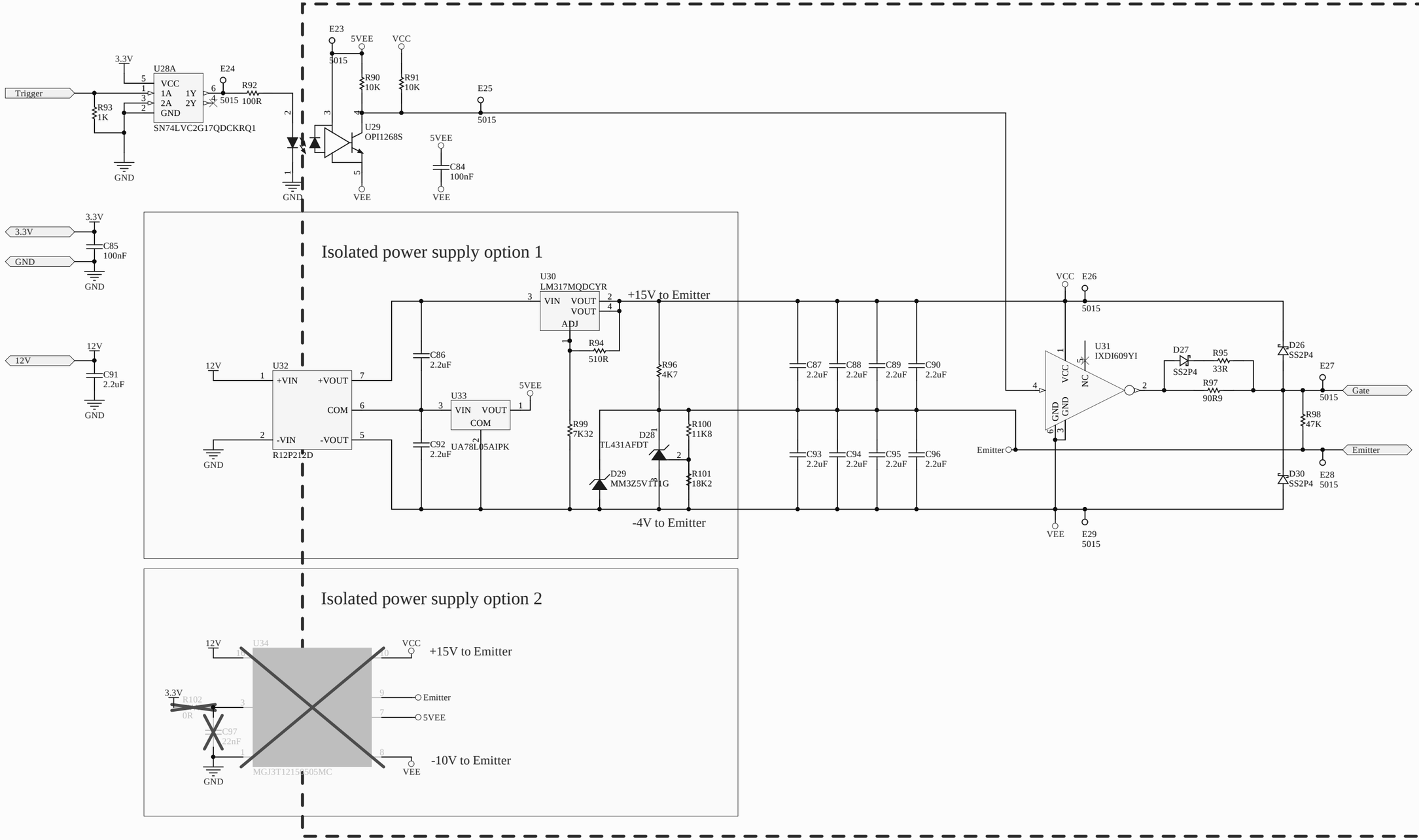
124K: 13.72V
91K: 10.34V

Bandwidth: 1/(10k*C*2*pi)
1nF: 15.9kHz

Sheet Title: *			*
Project Title: ***IgbtControl.PrjPcb***			* * * *
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:13 PM	Sheet * of *	
Author: *	File: Window_Comparator.SchDoc		



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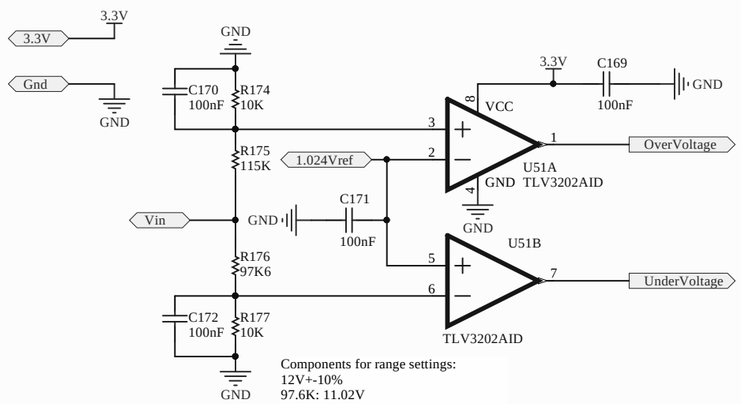
Project Title: ***IgbtControl.PrjPcb***			
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:13 PM	Sheet * of *	
Author: *	File: Isolated_Gate_Drive.SchDoc		



Components for range settings:
12V+-10%
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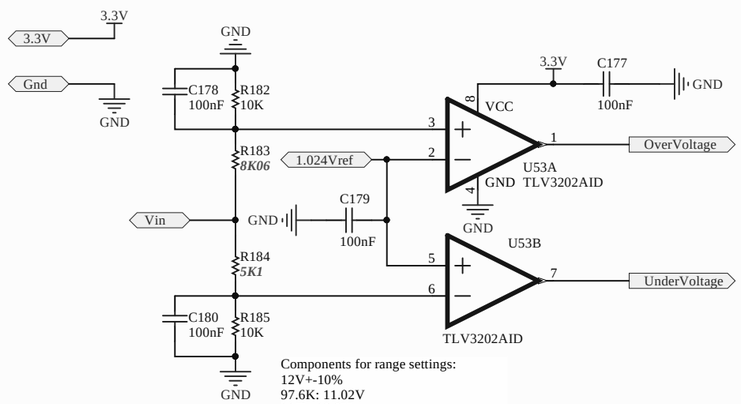
1nF: 15.9kHz

Sheet Title: *			*
Project Title: ***IgbtControl.PrjPcb***			* * * *
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:13 PM	Sheet * of *	
Author: *	File: Window_Comparator.SchDoc		



Components for range settings:
12V+-10%
97.6K: 11.02V
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Sheet Title: *			*
Project Title: ***IgbtControl.PrjPcb***			* * * * *
Size: Tabloid	Number:	Revision:	
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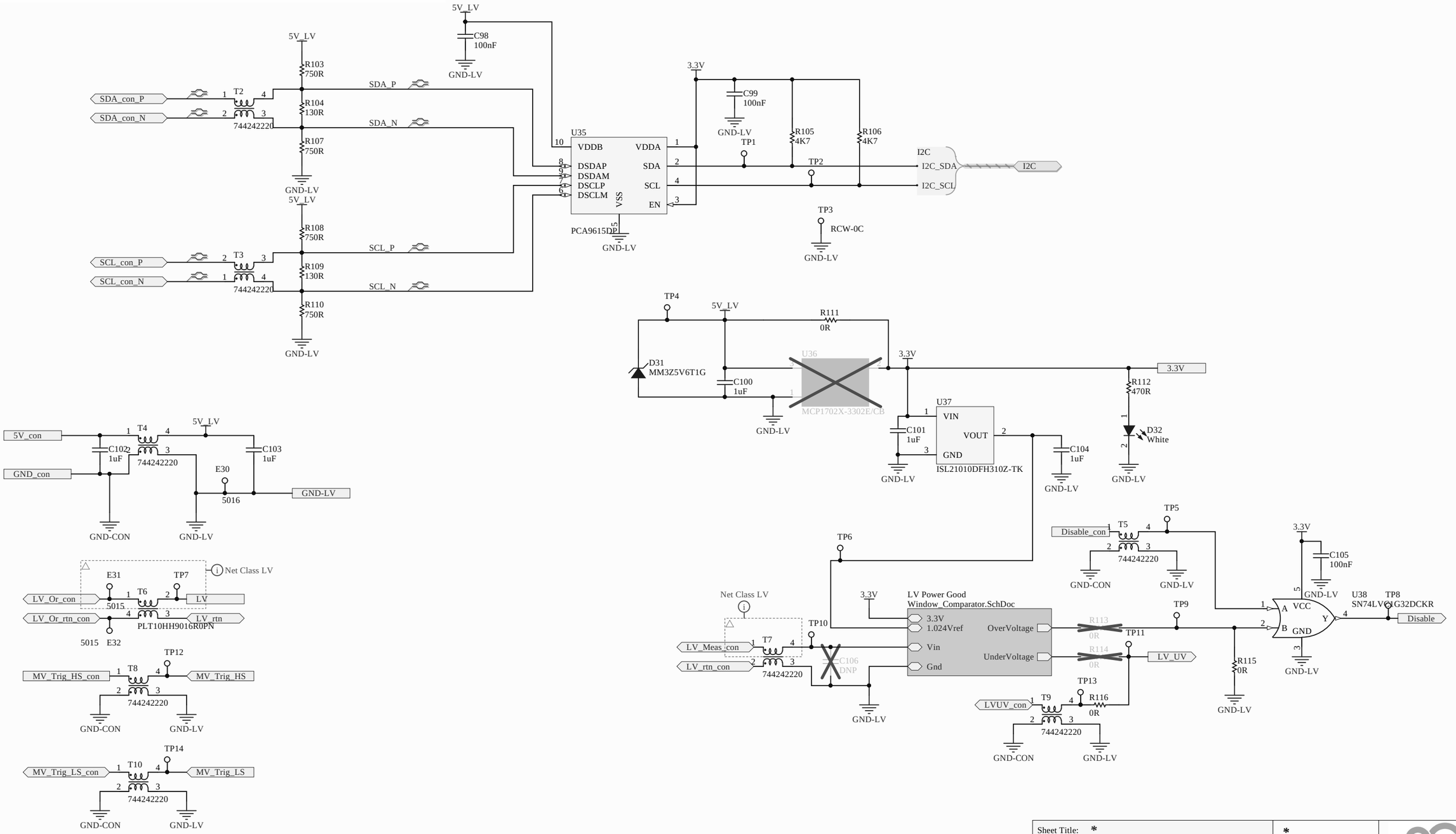
Author: *	File: Window_Comparator.SchDoc		

Termination resistor calaculation:
NXP uses CAT5 cable (100Ohm) therefore resistors are 332, 100, 332.
0.05" ribbon in GSG configuration: 470,140,470(https://hackaday.com/2017/03/31/an-introduction-to-differential-i%C2%B2c/)
0.05"ribbon in GSG 80Ohm
(https://www.te.com/commerce/DocumentDelivery/DDEController?Action=showdoc&DocId=Data+Sheet%7F1-1773862-3_IDC_Ribbon_Cable_Brochure_C0%7F0915%7Fpdf%7FEnglish%7FENG_DS_1-1773862-3_IDC_Ribbon_Cable_Brochure_C0_0915.pdf%7F1-57040-5
https://meritec.com/wp-content/uploads/2014/03/FFC-Impedance-Tests.pdf

Assume Z0=120 ohm in GSSG configuration:
According to TI AN-847 (http://www.ti.com/lit/an/snla031/snla031.pdf), 750/130/750 will be a good value



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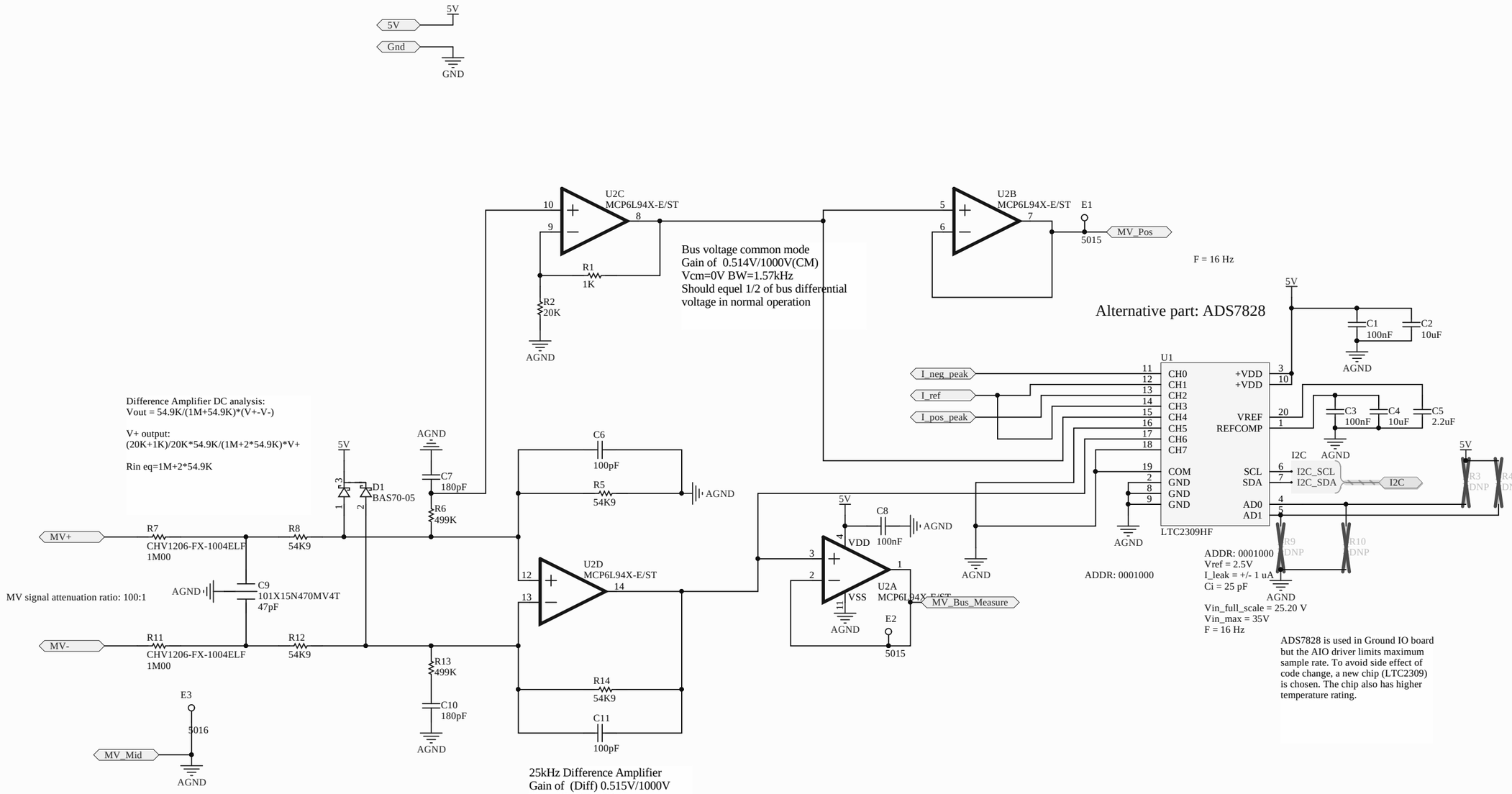
Size: Tabloid	Number: / Revision:
Date: 10/9/2019	Time: 4:35:13 PM / Sheet 5 of *
Author: *	File: LV_Interface.SchDoc



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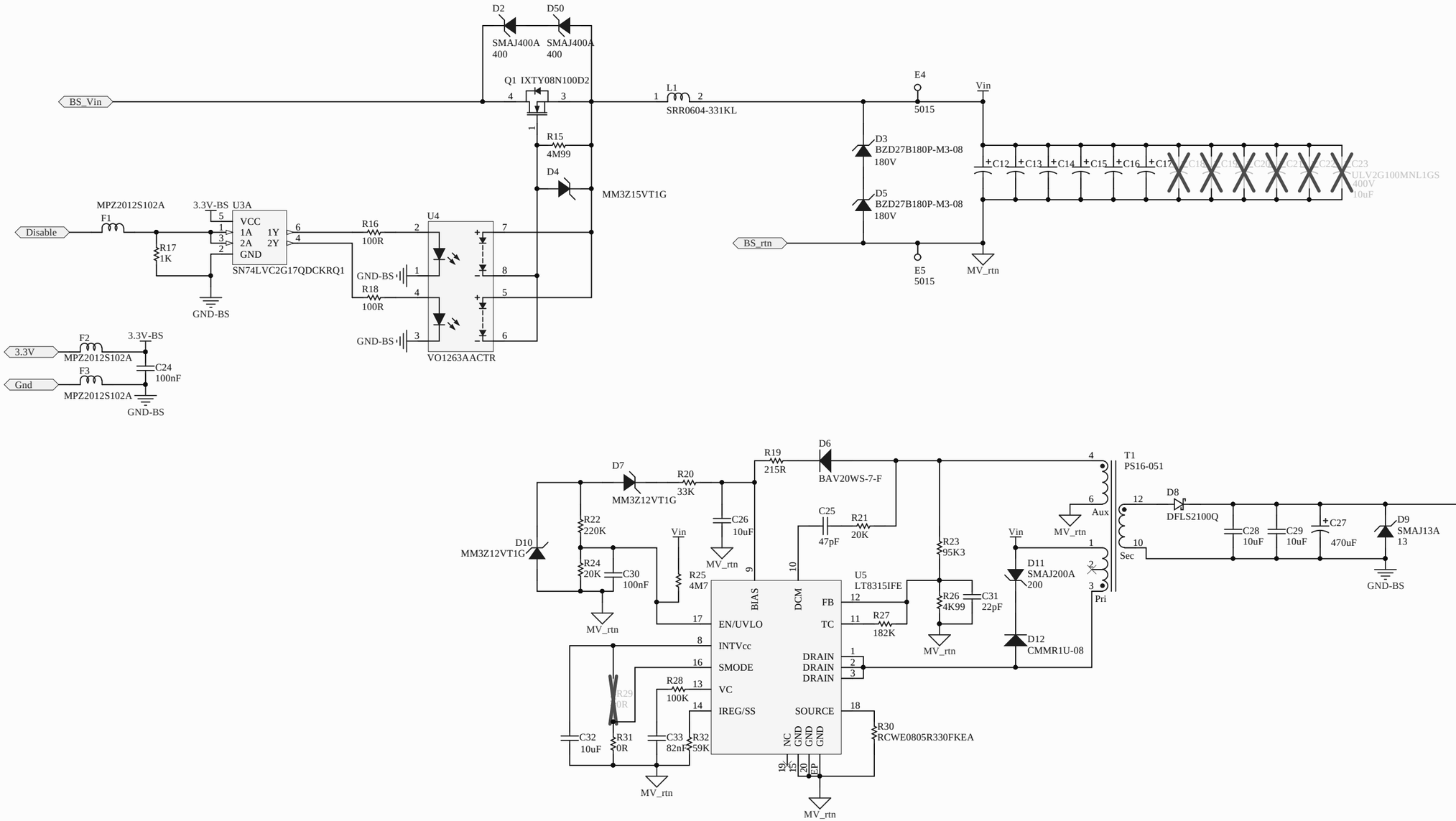
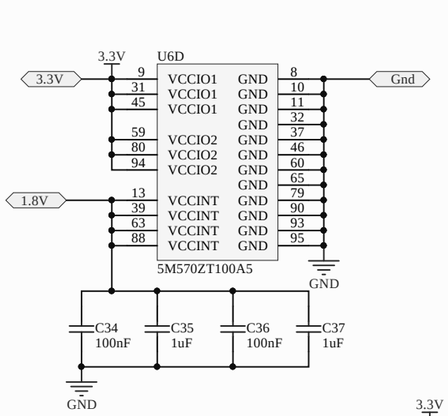
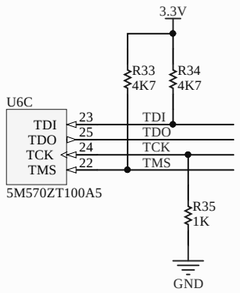
Project Title: *IgbtControl.PrjPcb*			* * * * *
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:14 PM	Sheet * of *	
Author: *	File: ADC_4CH_DIFF.SchDoc		

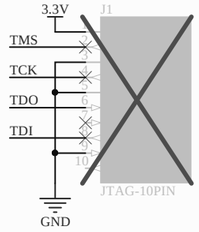


From DC2337A demo board design:
http://www.analog.com/media/en/dsp-documentation/evaluation-kit-manuals/DC2337AF.PDF

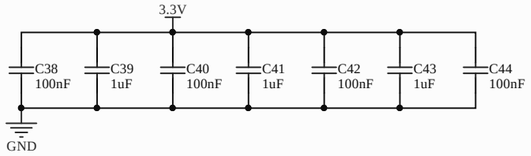
Sheet Title: *			**Makani Project**
Project Title: ***IgbtControl.PrjPcb***			*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019 Time: 4:35:14 PM	Sheet * of *		
Author: *	File: Bootstrap.SchDoc		

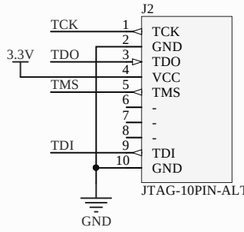




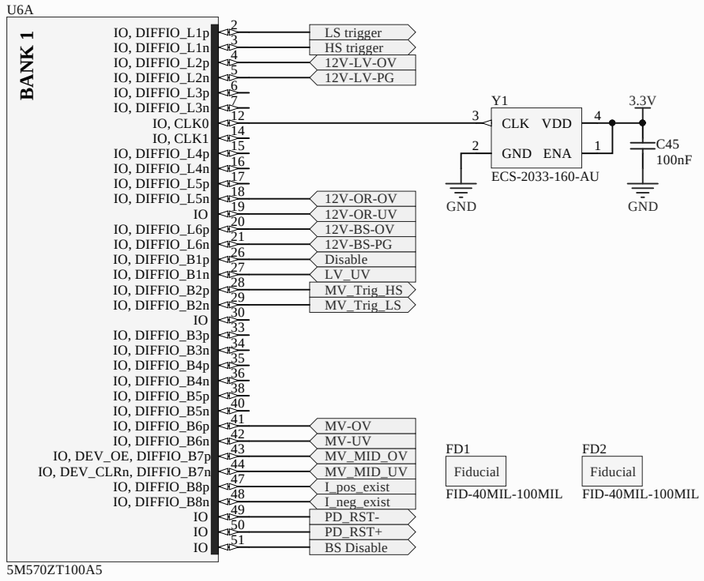


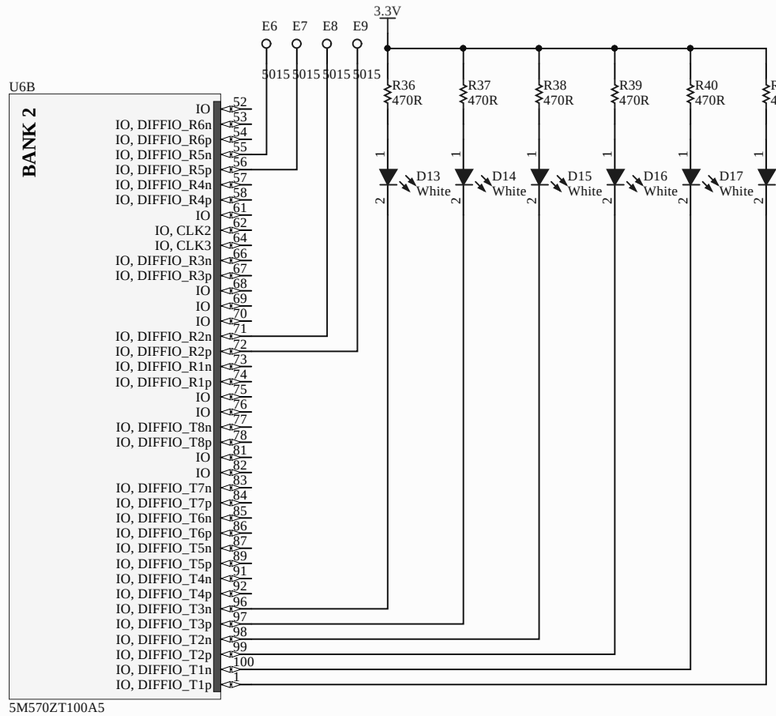
ARM JTAG





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





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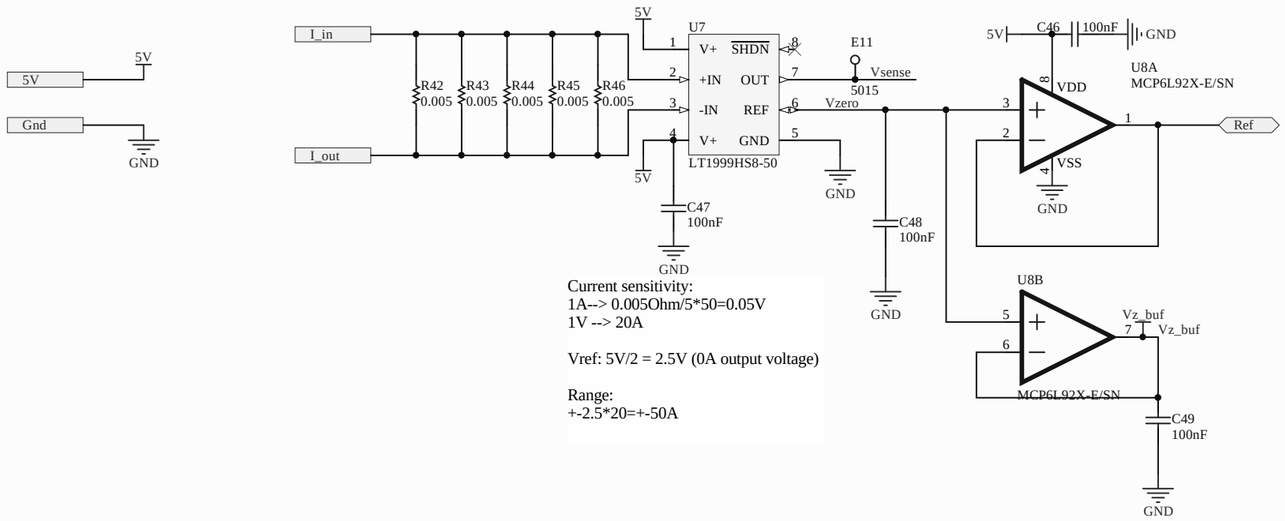
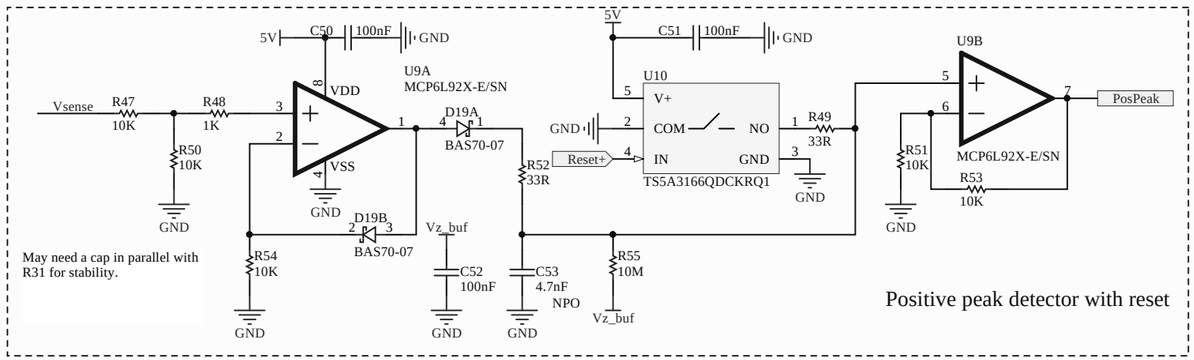
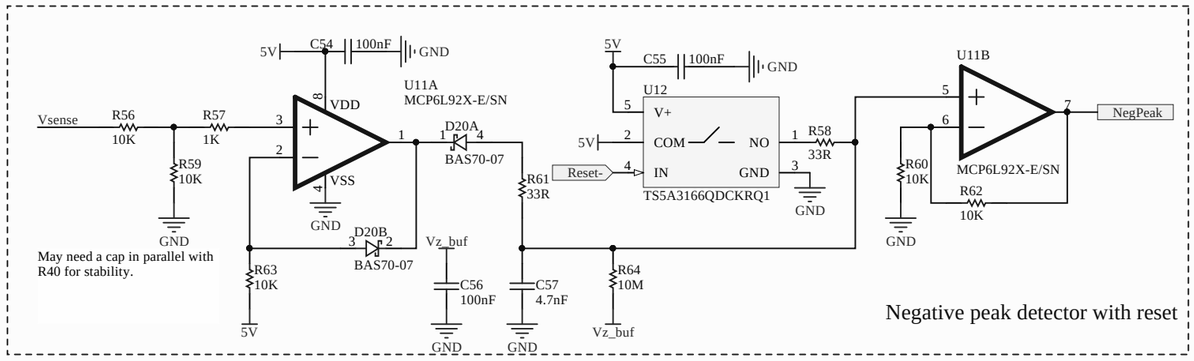
Size: Tabloid	Number:	Revision:	*
Date: 10/9/2019	Time: 4:35:14 PM	Sheet * of *	*
Author: *	File: CPLD_Controller.SchDoc		





BAS70-07 from Infinion for matched pair.
BAS7007E6327HTSA1
Digikey PN
BAS7007E6327HTSA1CT-ND



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Project Title: *IgbtControl.PrjPcb*			*
Size: Tabloid	Number:	Revision:	*
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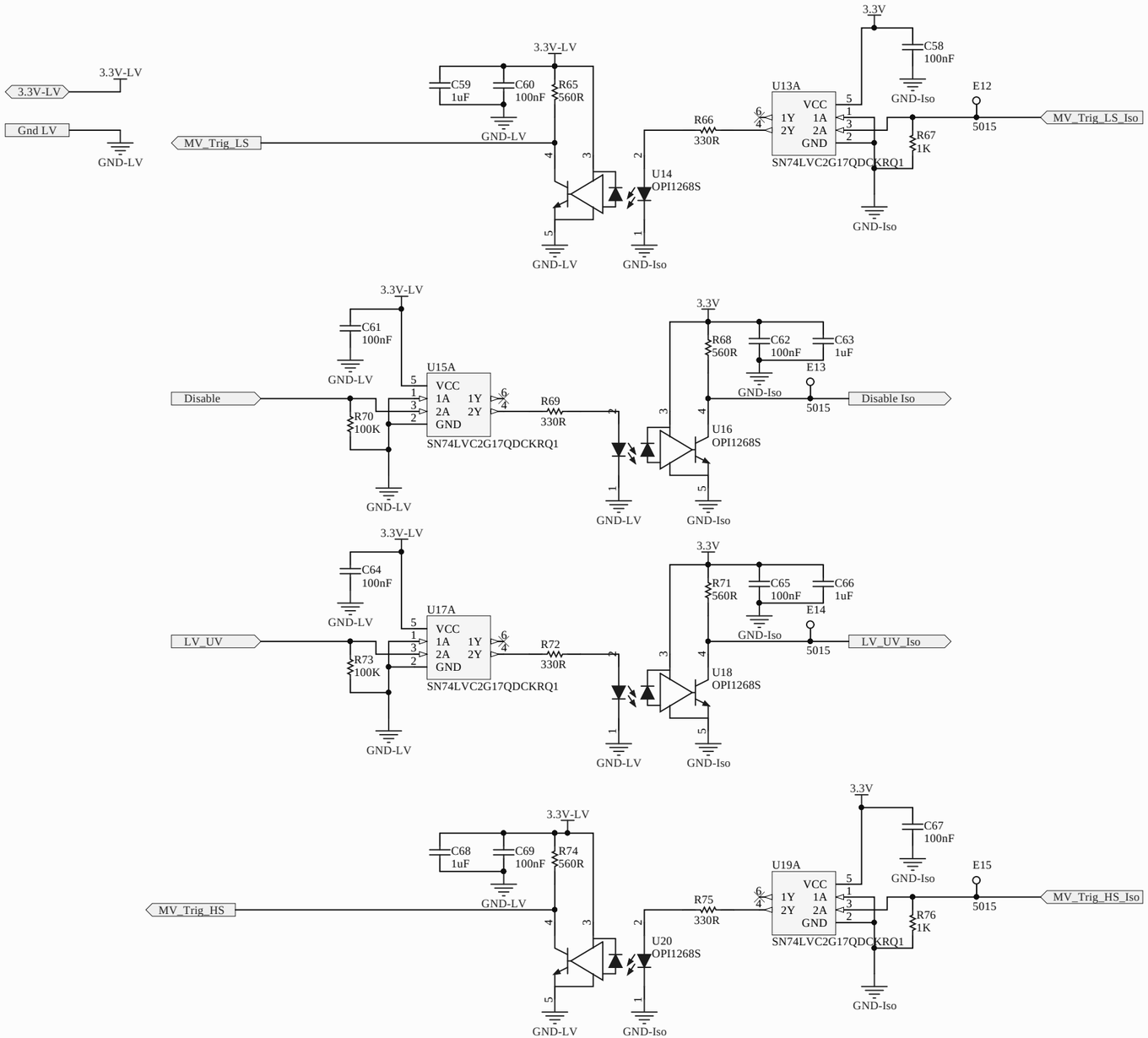
Author: *	File: Current_Sensor.SchDoc		

This configuration is a non-inverting buffer. Need to check turn-on/turn-off conditions



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Size: Tabloid	Number:	Revision:	
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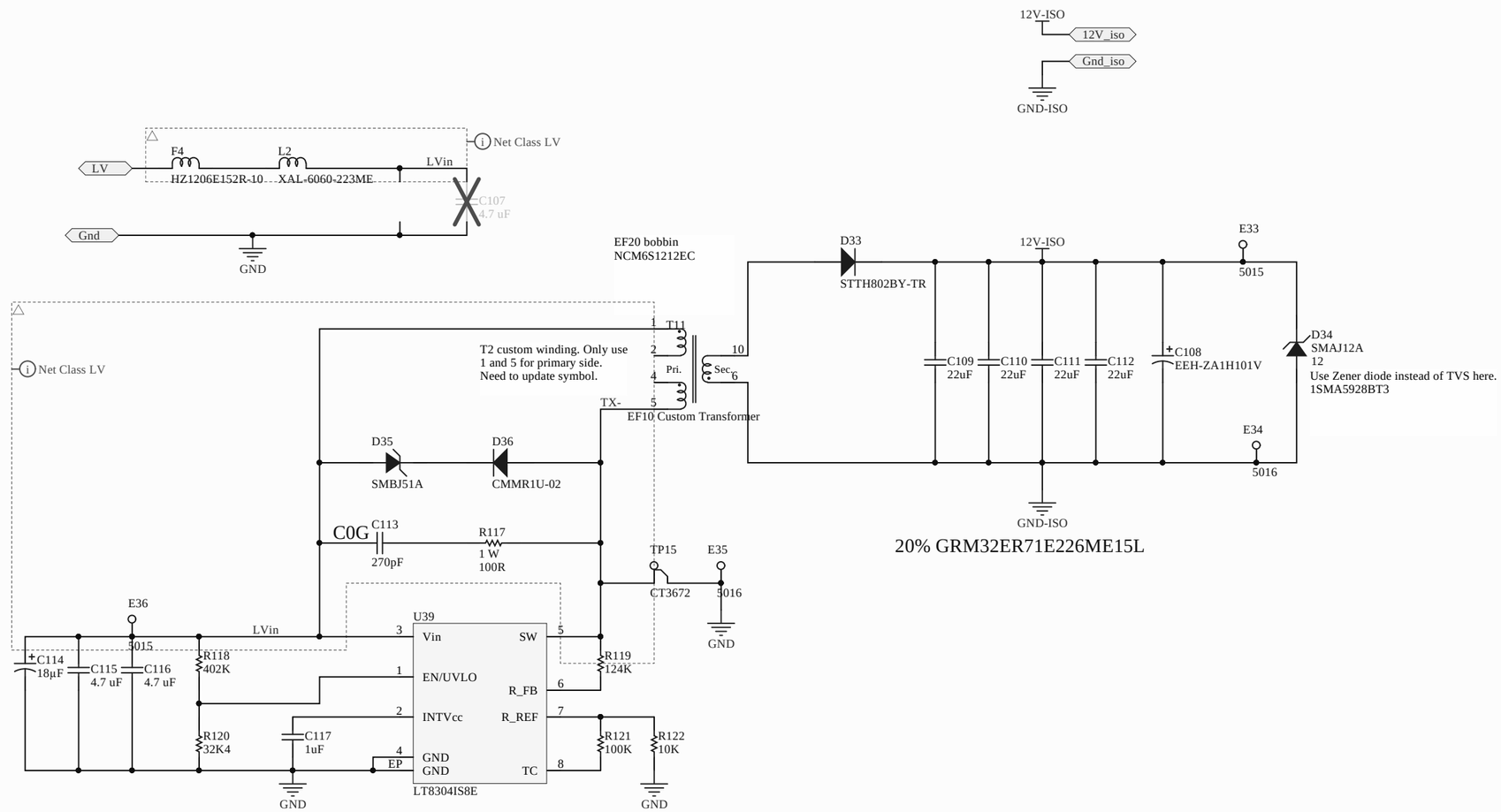
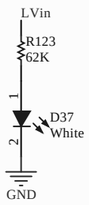
Author: *	File: Isolated_Control.SchDoc		

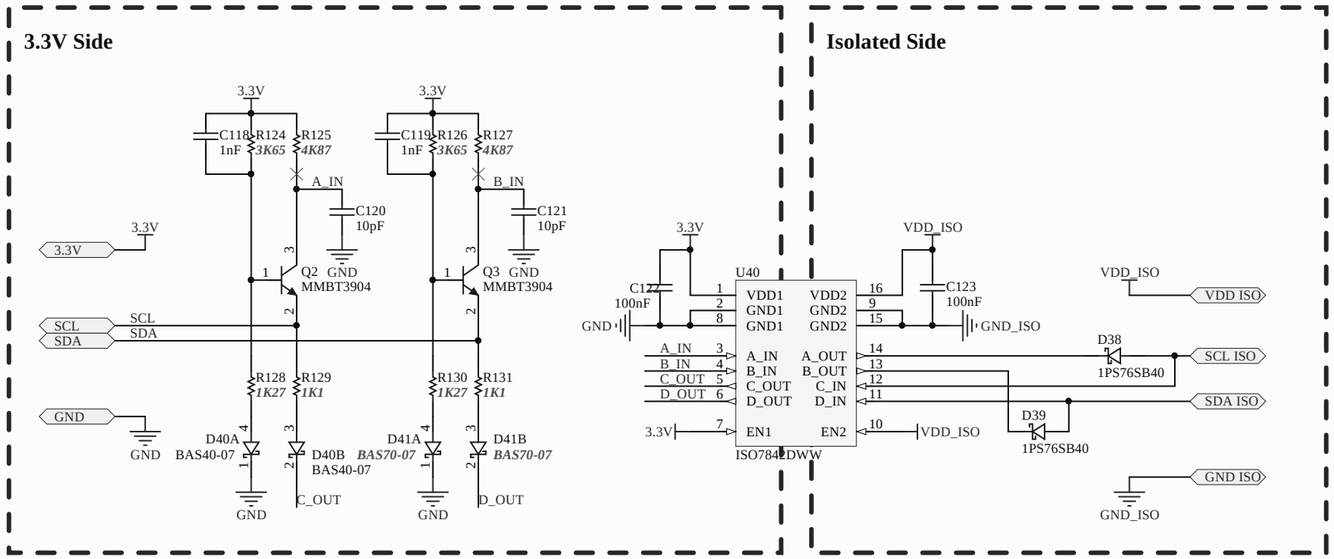


From LT8304 demo board:
http://www.analog.com/media/en/dsp-documentation/evaluation-kit-manuals/DC2393AF.PDF

Vout = Rfb/Rref*Vref/Nps-Vd=124k/10k*1V*1-0.4=12V
4.7u cap: GRJ32DC72A475KE11L



Sheet Title: *			**Makani Project**
Project Title: ***IgbtControl.PrjPcb***			*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019 Time: 4:35:14 PM	Sheet * of *		
Author: *	File: LV_Isolation.SchDoc		



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)

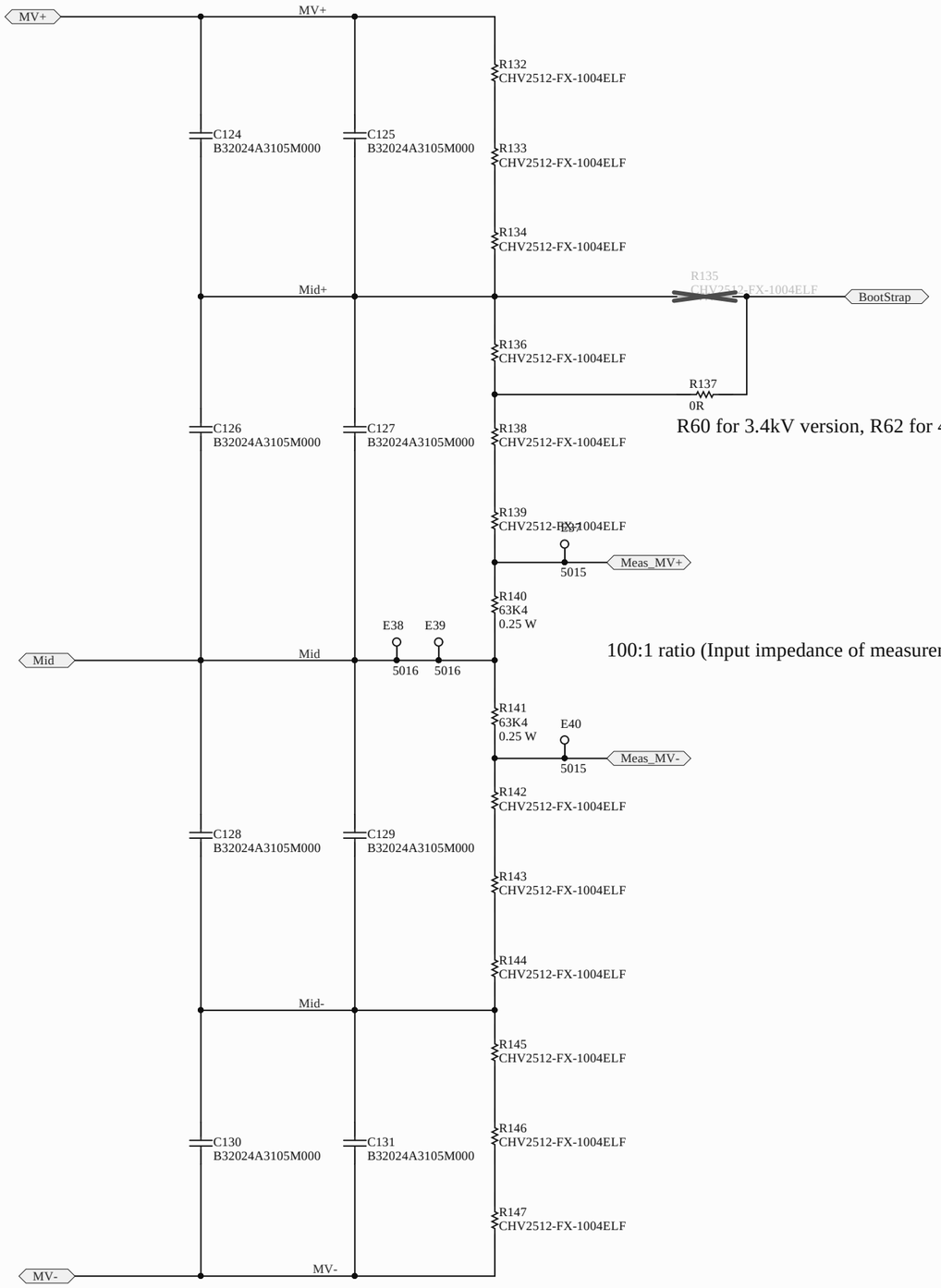
VCC_ISO	DC power of output side, 2.5V to 5V
GND_ISO	Ground of output side
SCL_ISO	I2C bus clock output on VCC2 side, bidirectional
SDA_ISO	I2C bus data I/O on VCC2 side, bidirectional

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*			***Makani Project*** *Google Inc. 2175 Monarch St. Alameda CA, 94501 USA*
Project Title: ***IgbtControl.PrjPcb***			
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:14 PM	Sheet * of *	
Author: TT	File: MMS-0001-00043-A.11.SchDoc		



R60 for 3.4kV version, R62 for 4.8kV version

100:1 ratio (Input impedance of measurement circuit is 1M+2*54.9k)

Sheet Title: *		
Project Title: ***IgbtControl.PrjPcb***		
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Author: *	File: MV_Bus_Capacitors.SchDoc	

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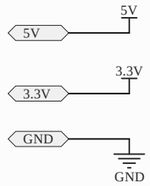
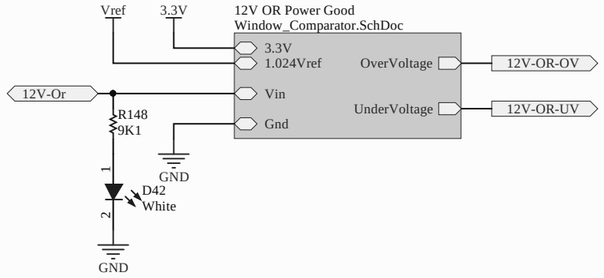
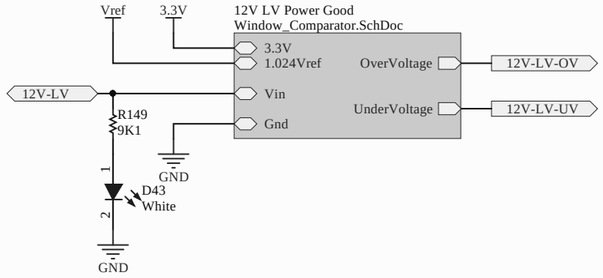
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA

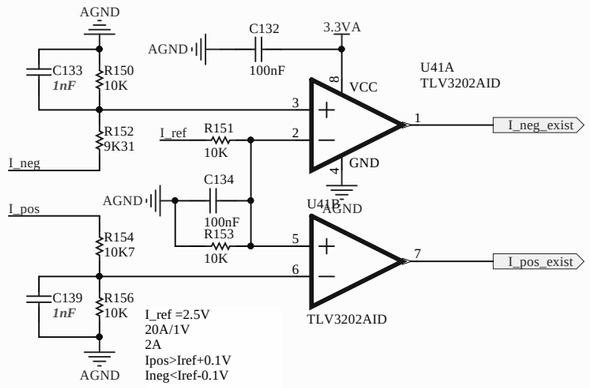


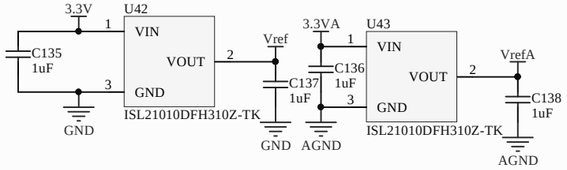


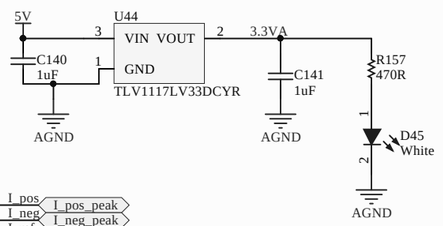


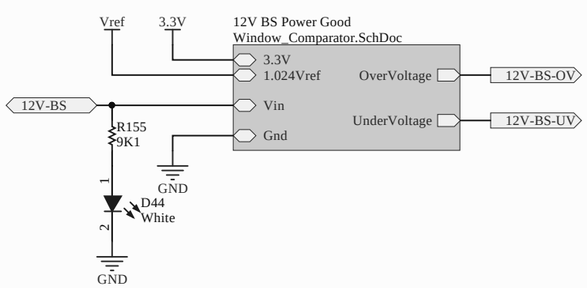
Difference amplifier to converter differential signal to single ended.
Compare with reference

CPLD for fast fault handling
Slow signal can be processed by AIO on LV side
12V power should be processed by CPLD to determine operation mode (BS vs Normal)

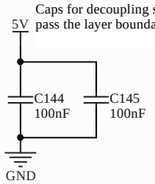


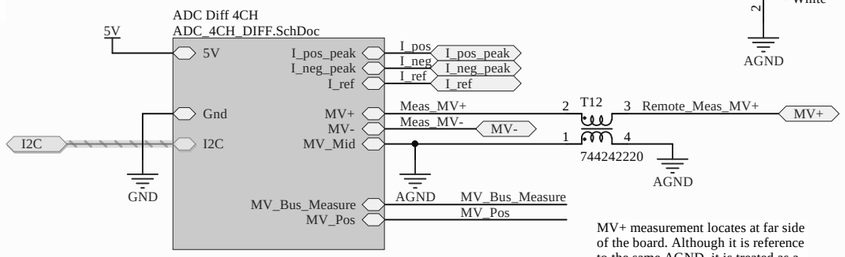






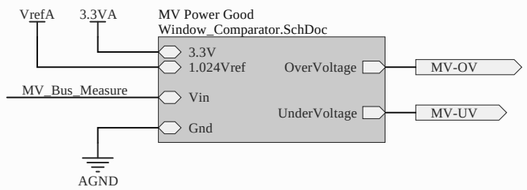
Caps for decoupling signal while pass the layer boundary.



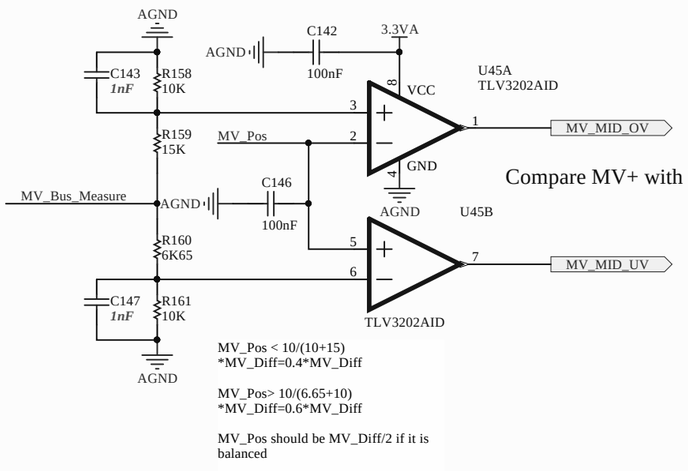


Seperated ground for noise immunity

MV+ measurement locates at far side of the board. Although it is reference to the same AGND, it is treated as a differential signal here. A long PCB trace of AGND from far side should run with the signal.

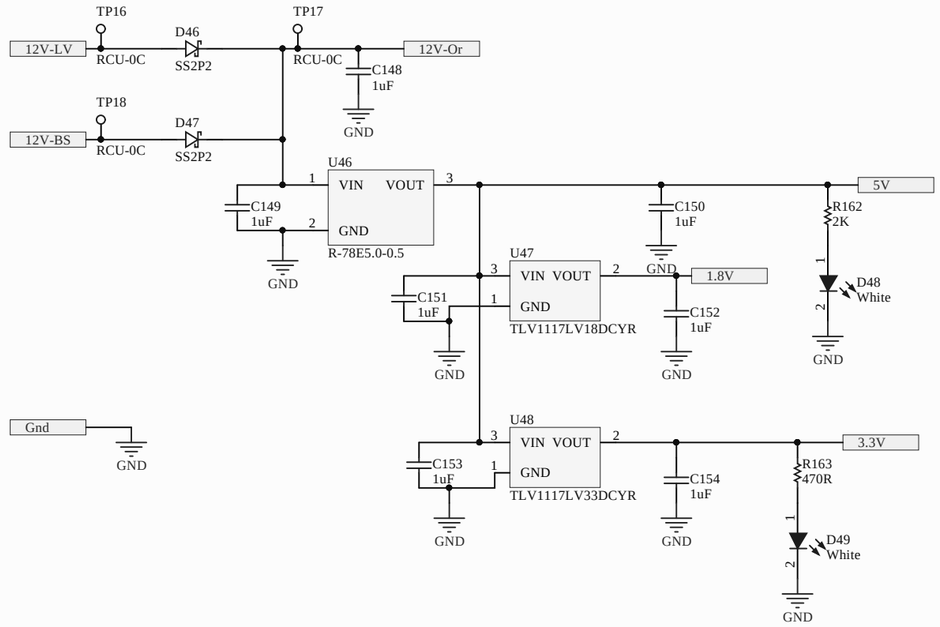


Current: 20A/1V; Voltage 0.515V/1000V



Compare MV+ with MV/2, if the difference is too much, MV is not balanced

Sheet Title: *			**Makani Project**
Project Title: ***IgbtControl.PrjPcb***			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 10/9/2019	Time: 4:35:15 PM	Sheet * of *	*Alameda CA, 94501*
Author: *	File: MV_Measurement.SchDoc		*USA*



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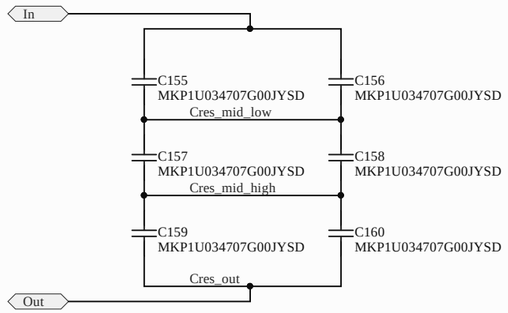
Author: *	File: MV_Power.SchDoc		



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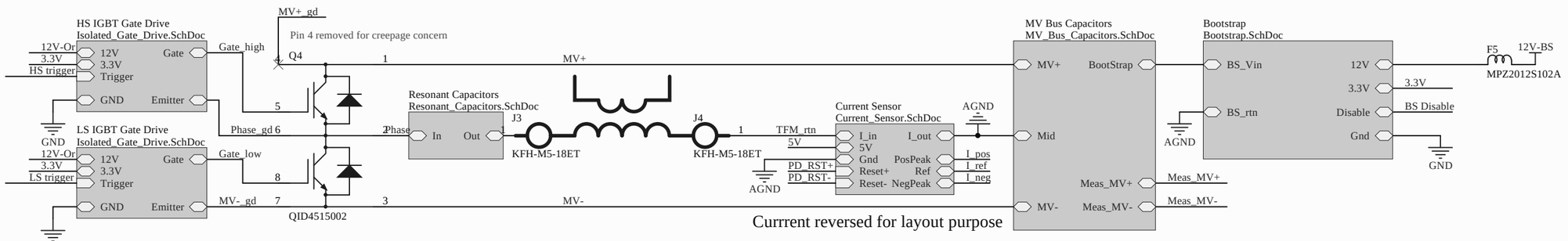
Project Title: ***IgbtControl.PrjPcb***			
Size: Tabloid	Number:	Revision:	
Date: 10/9/2019	Time: 4:35:15 PM	Sheet * of *	
Author: *	File: Resonant_Capacitors.SchDoc		

Naming convention:
1. LV side netname ends with "-LV".



Clearance and creepage:

12V:

Clearance from Ozone:
1.6kV: 5mm
4.8kV: 12mm
4.1kV: 10mm
1.45kV 4mm

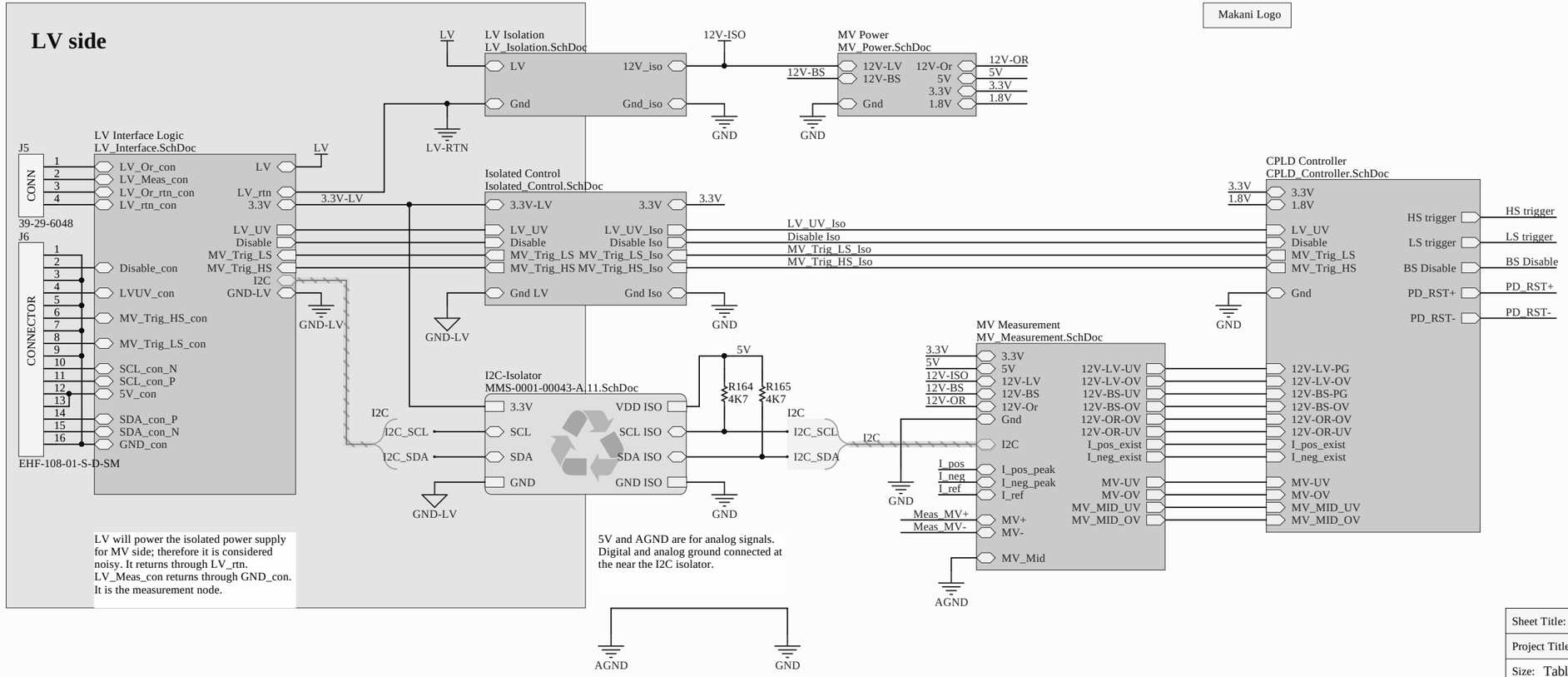
Creepage from Ozone:
1.2kV 6(PCB), 12mm
1.8kV 18mm
2.4kV 24mm
640V: 3.5(PCB), 6.5mm
1.76kV: 18mm

Voltage calculation:
Max normal operation voltage
MV+: 2400V
MV-: -2400V
IGBT PH: +-2n*72

FD3 Fiducial FID-40MIL-100MIL
FD4 Fiducial FID-40MIL-100MIL
FD5 Fiducial FID-40MIL-100MIL
FD6 Fiducial FID-40MIL-100MIL
FD7 Fiducial FID-40MIL-100MIL
FD8 Fiducial FID-40MIL-100MIL

Makani Logo

LV side



LV will power the isolated power supply for MV side; therefore it is considered noisy. It returns through LV_rtn. LV_Meas_con returns through GND_con. It is the measurement node.

5V and AGND are for analog signals. Digital and analog ground connected at the near the I2C isolator.

Sheet Title: *			**Makani Project**
Project Title: ***IgbtControl.PrjPcb***			*Google Inc.*
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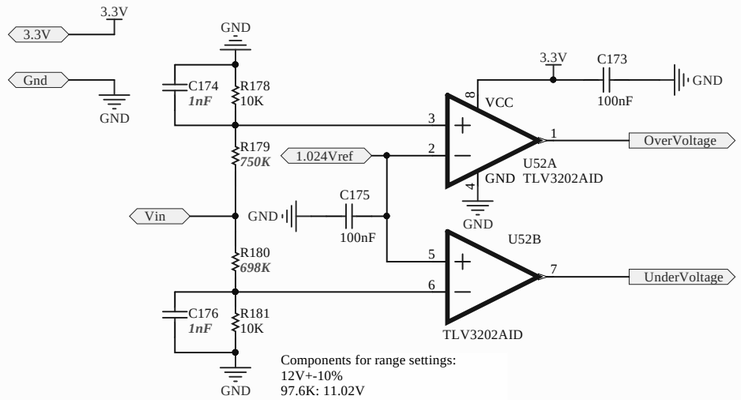
Author: *	File: TopLevel.SchDoc		*USA*



Components for range settings:
12V+-10%
97.6K: 11.02V
115k: 12.8V
698K (1206)CMP-0001-03688: 72.5V

124K: 13.72V
91K: 10.34V

Bandwidth: 1/(10k*C*2*pi)
1nF: 15.9kHz

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Project Title: ***IgbtControl.PrjPcb***			* * * * *
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