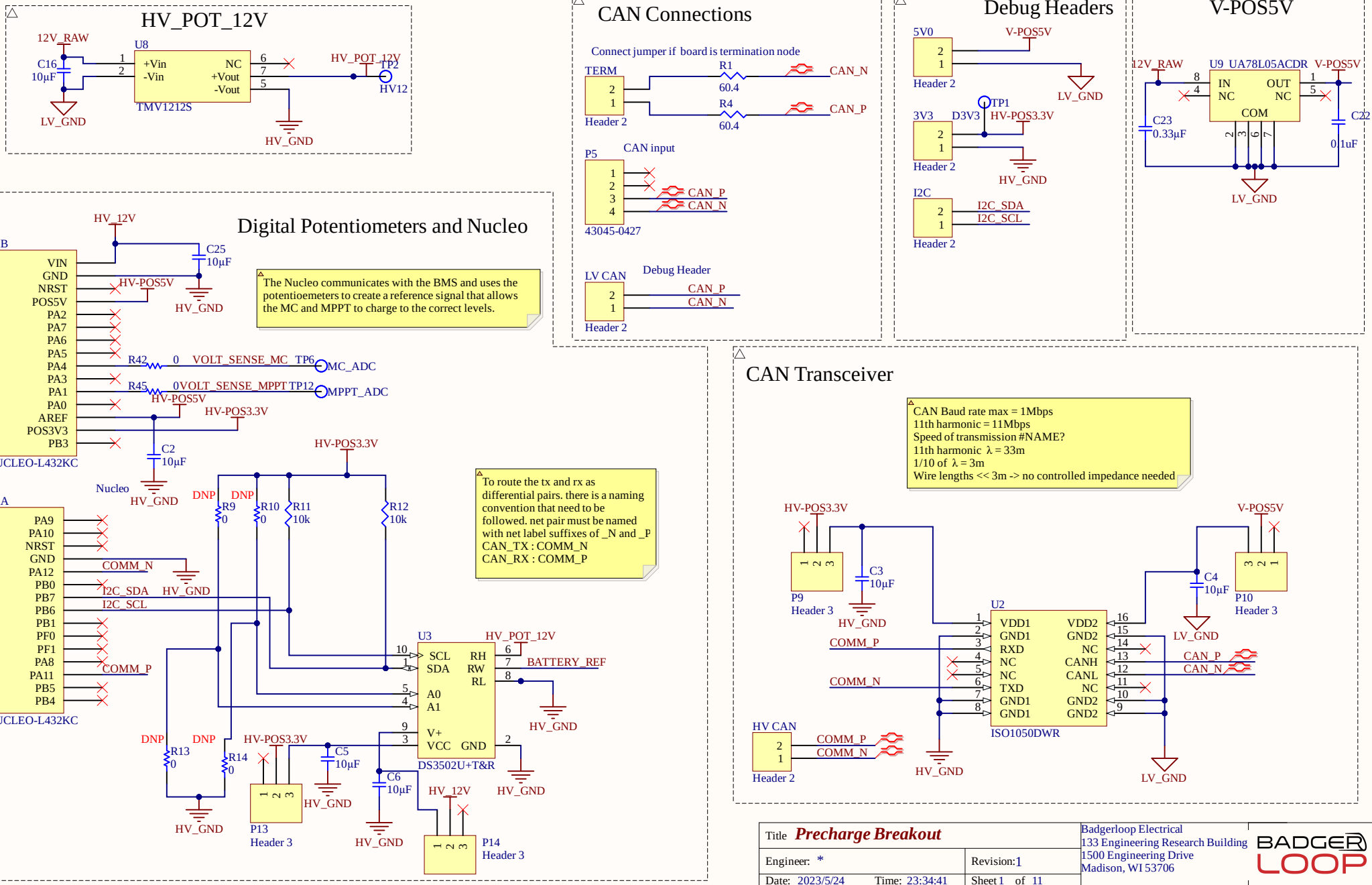
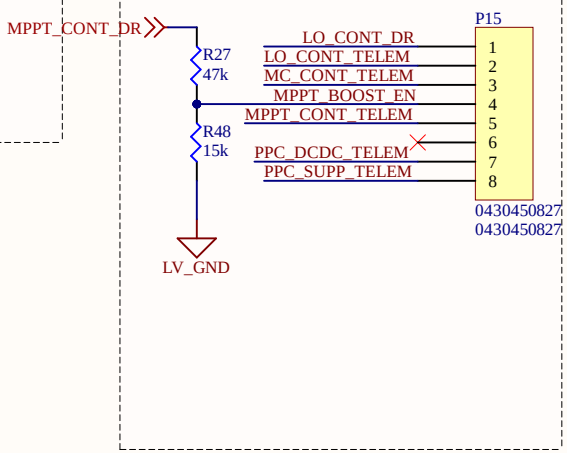

HV_POT_12V
12V_RAW
C16
10µF
LV_GND
U8
+Vin
-Vin
NC
+Vout
-Vout
TMV1212S
HV_GND
HV_POT_12V
TP2
HV12
CAN Connections
Connect jumper if board is termination node
TERM
Header 2
R1
60.4
R4
60.4
CAN_N
CAN_P
P5
CAN input
43045-0427
LV CAN
Debug Header
Debug Headers
5V0
V-POS5V
LV_GND
TP1
3V3
D3V3
HV-POS3.3V
HV_GND
I2C
I2C_SDA
I2C_SCL
V-POS5V
U9_UA78L05ACDR
IN
OUT
NC
COM
C23
0.33µF
C22
0.1uF
Digital Potentiometers and Nucleo
HV_12V
U1B
VIN
GND
NRST
POS5V
PA2
PA7
PA6
PA5
PA4
PA3
PA1
PA0
AREF
POS3V3
PB3
NUCLEO-L432KC
C25
10µF
HV-POS5V
The Nucleo communicates with the BMS and uses the potentioemeters to create a reference signal that allows the MC and MPPT to charge to the correct levels.
R42
0
VOLT_SENSE_MC
TP6
MC_ADC
R45
0
VOLT_SENSE_MPPT
TP12
MPPT_ADC
HV-POS3.3V
C2
10µF
Nucleo
U1A
PA9
PA10
NRST
GND
PA12
PB0
PB7
PB6
PB1
PF0
PF1
PA8
PA11
PB5
PB4
NUCLEO-L432KC
COMM_N
I2C_SDA
I2C_SCL
COMM_P
DNP
R9
0
R10
0
R11
10k
R12
10k
To route the tx and rx as differential pairs. there is a naming convention that need to be followed. net pair must be named with net label suffixes of _N and _P
CAN_TX : COMM_N
CAN_RX : COMM_P
U3
SCL
SDA
A0
A1
V+
VCC
RH
RW
RL
GND
DS3502U+T&R
HV_POT_12V
BATTERY_REF
R13
0
R14
0
C5
10µF
C6
10µF
P13
Header 3
P14
Header 3
CAN Transceiver
CAN Baud rate max = 1Mbps
11th harmonic = 11Mbps
Speed of transmission #NAME?
11th harmonic λ = 33m
1/10 of λ = 3m
Wire lengths << 3m -> no controlled impedance needed
P9
Header 3
C3
10µF
C4
10µF
P10
Header 3
U2
VDD1
GND1
RXD
NC
NC
TXD
GND1
GND1
VDD2
GND2
NC
CANH
CANL
NC
GND2
GND2
ISO1050DWR
HV CAN
Header 2
Title Precharge Breakout
Engineer: *
Revision:1
Date: 2023/5/24 Time: 23:34:41
Sheet 1 of 11
File: digital.SchDoc
Badgerloop Electrical
133 Engineering Research Building
1500 Engineering Drive
Madison, WI 53706
BADGER LOOP

Test Signals

Verify All The Signals

Low Voltage Input and Output



MH1
4-40 Mount Hole

MH2
4-40 Mount Hole

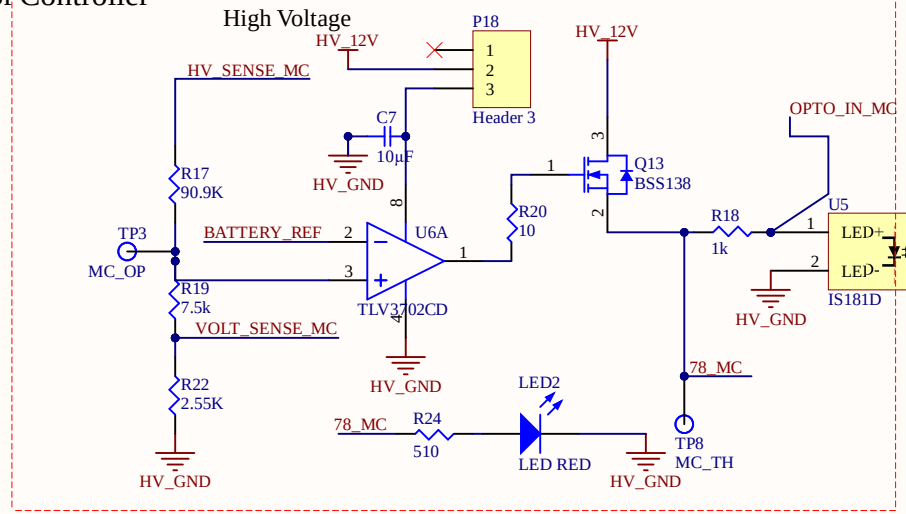
MH3
4-40 Mount Hole

MH4
4-40 Mount Hole

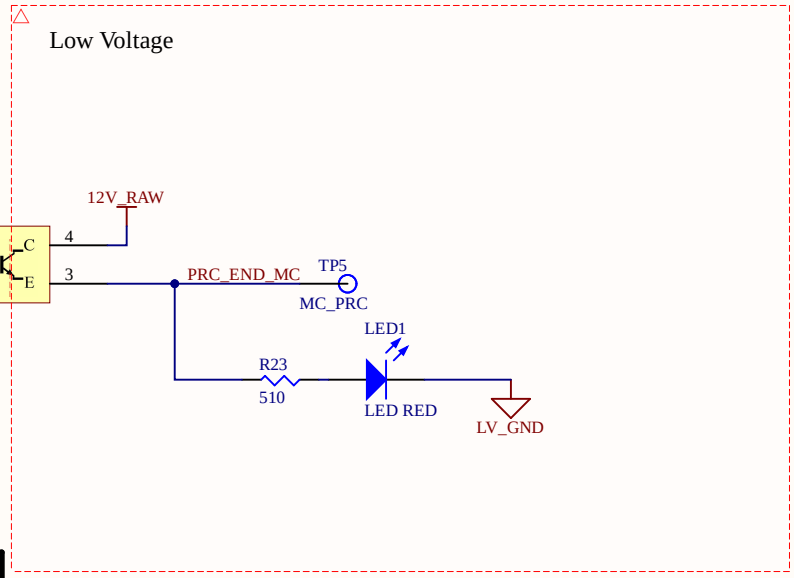
Title	***Precharge Breakout***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706
Engineer: *	Revision:*	
Date: 2023/5/24 Time: 23:34:42	Sheet 2 of 11	
File: connectors.SchDoc		

Motor Controller

High Voltage

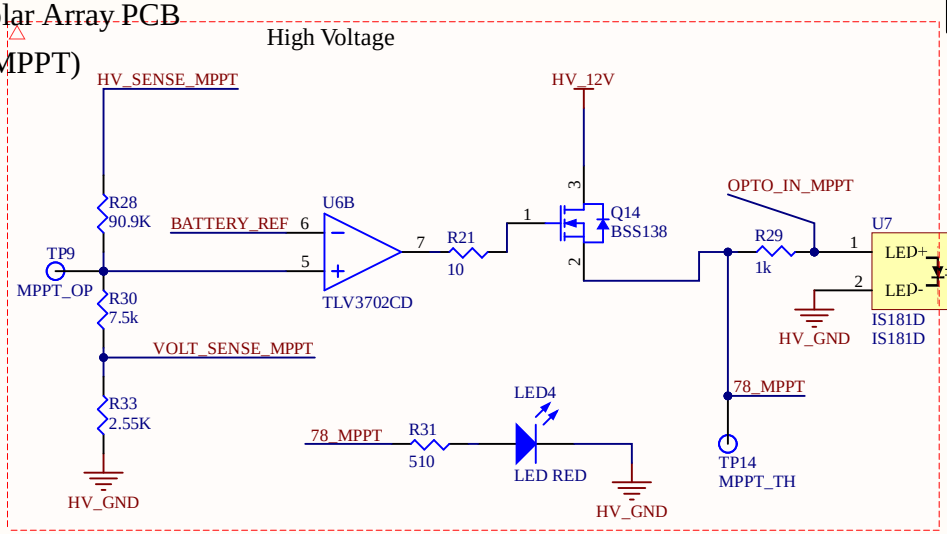


Low Voltage

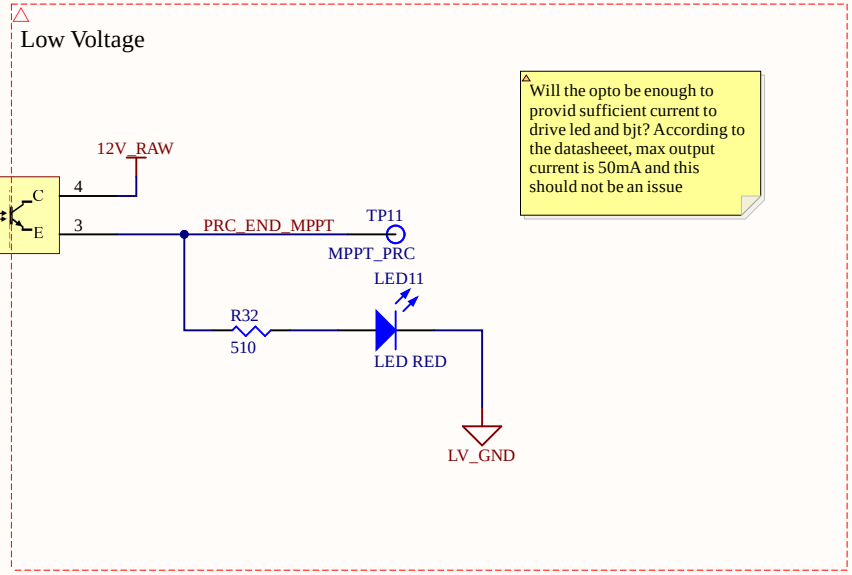


Solar Array PCB (MPPT)

High Voltage



Low Voltage



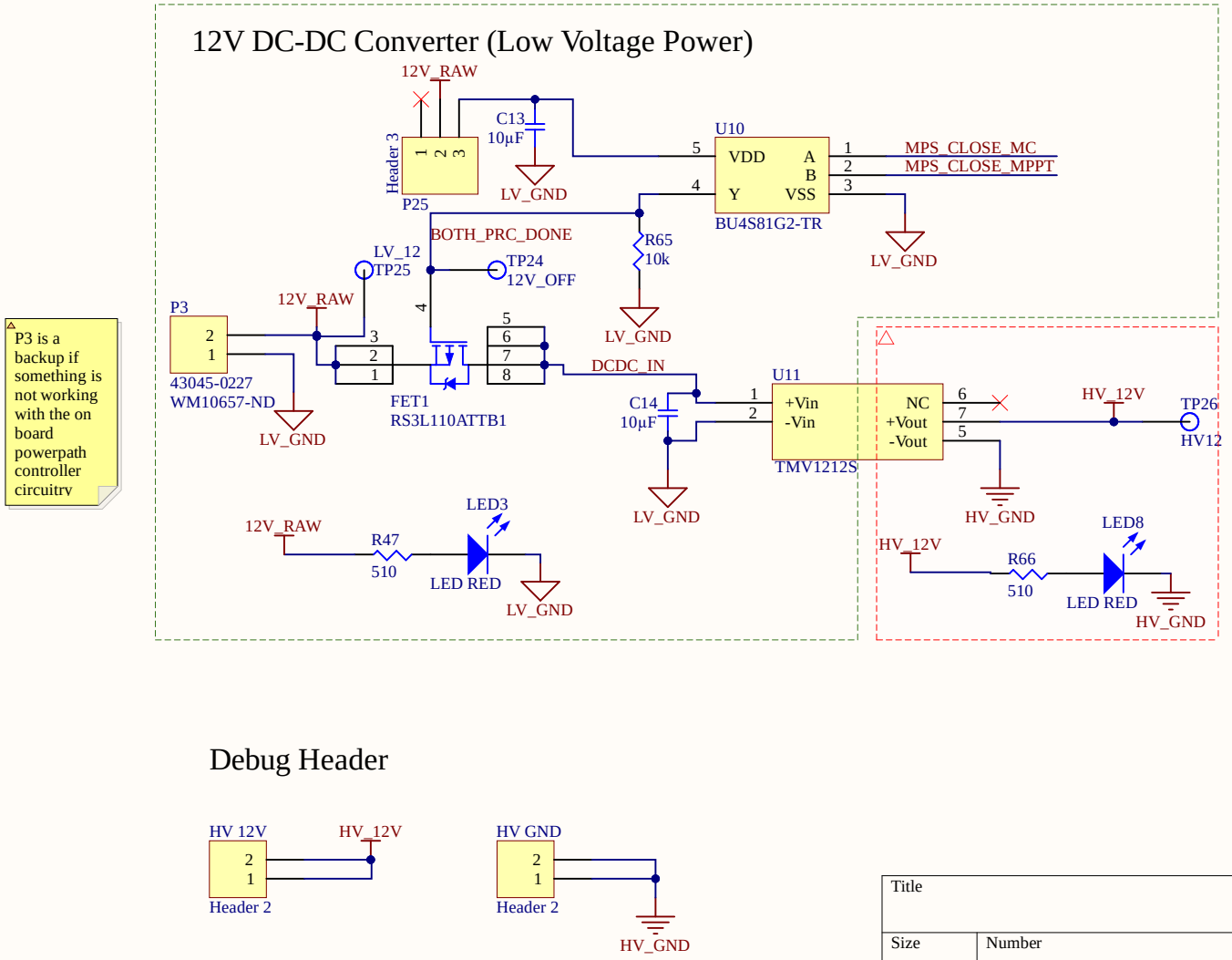
Will the opto be enough to provid sufficient current to drive led and bjt? According to the datasheeet, max output current is 50mA and this should not be an issue

HV_OUT_MPPT TP15 MPPT_HV

TP13 MPPT_HV

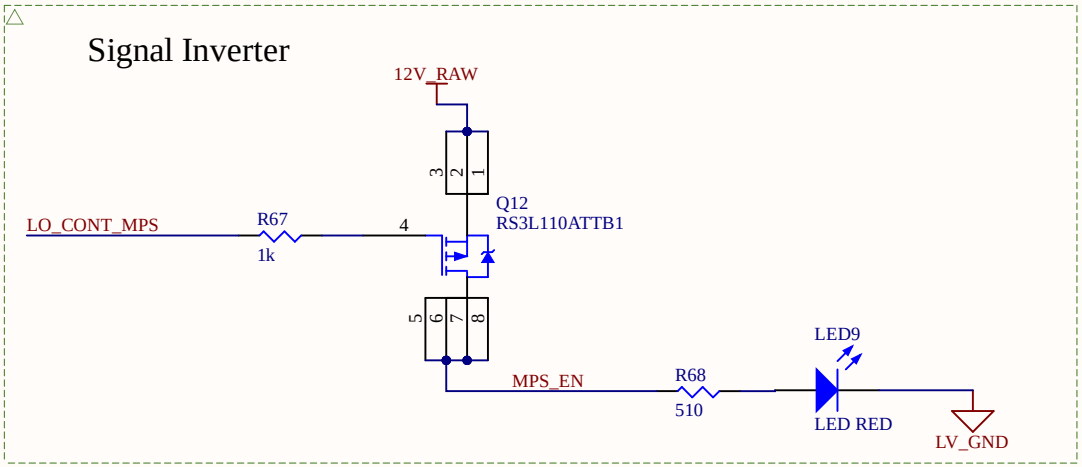
HV_GND

Title	***Precharge Breakout***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706
Engineer: *	Revision: 1	
Date: 2023/5/24 Time: 23:34:42	Sheet 3 of 11	
File: voltage_sense.SchDoc		



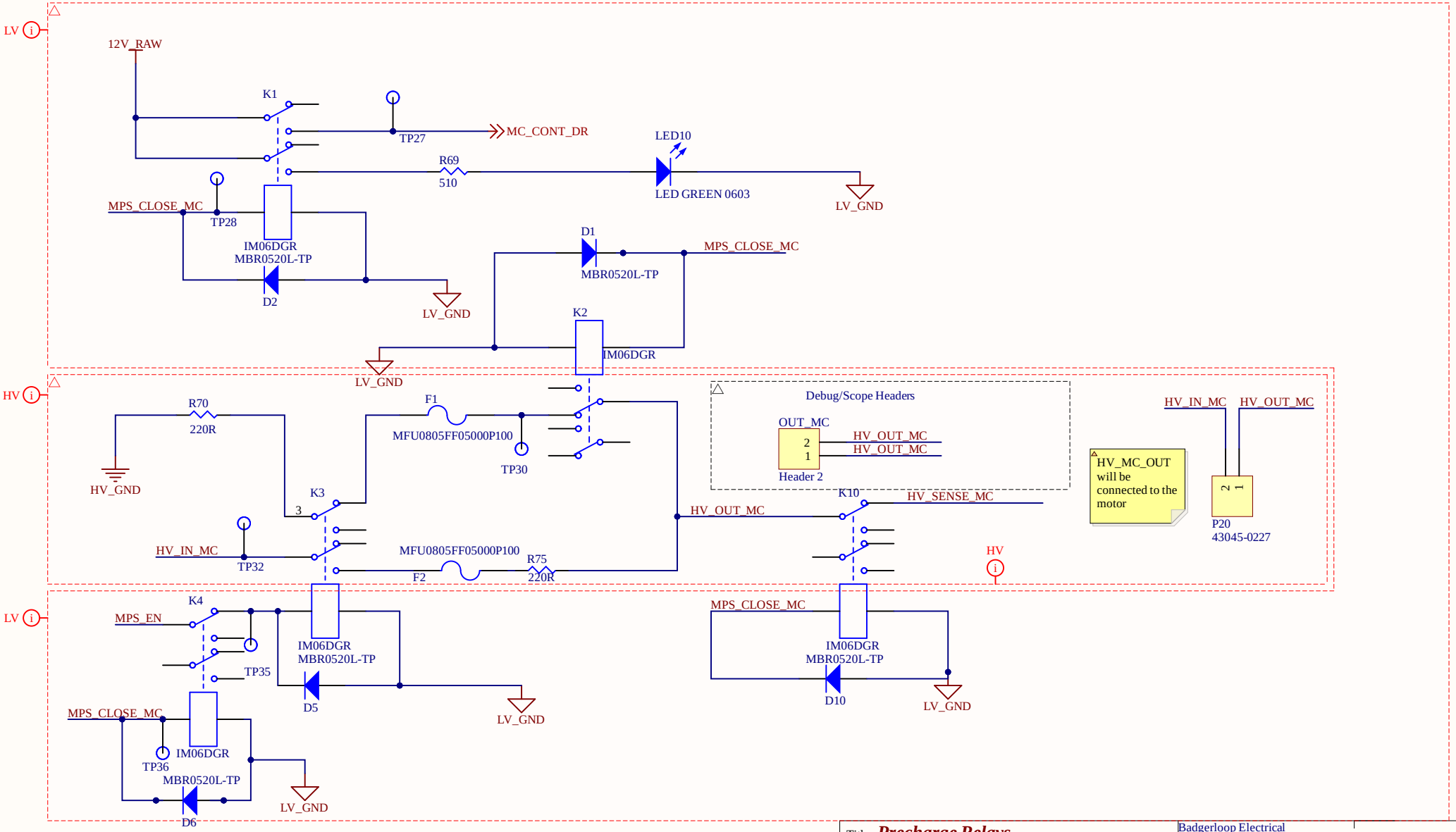
Title		
Size: A	Number:	Revision:
Date: 5/24/2023		Sheet of
File: D:\AD工程\..\12V dc-dc converter.SchDoc		Drawn By:

Signal Inverter



Title		
Size: A	Number	Revision
Date: 5/24/2023		Sheet of
File: D:\AD工程\..\inverter.SchDoc		Drawn By:

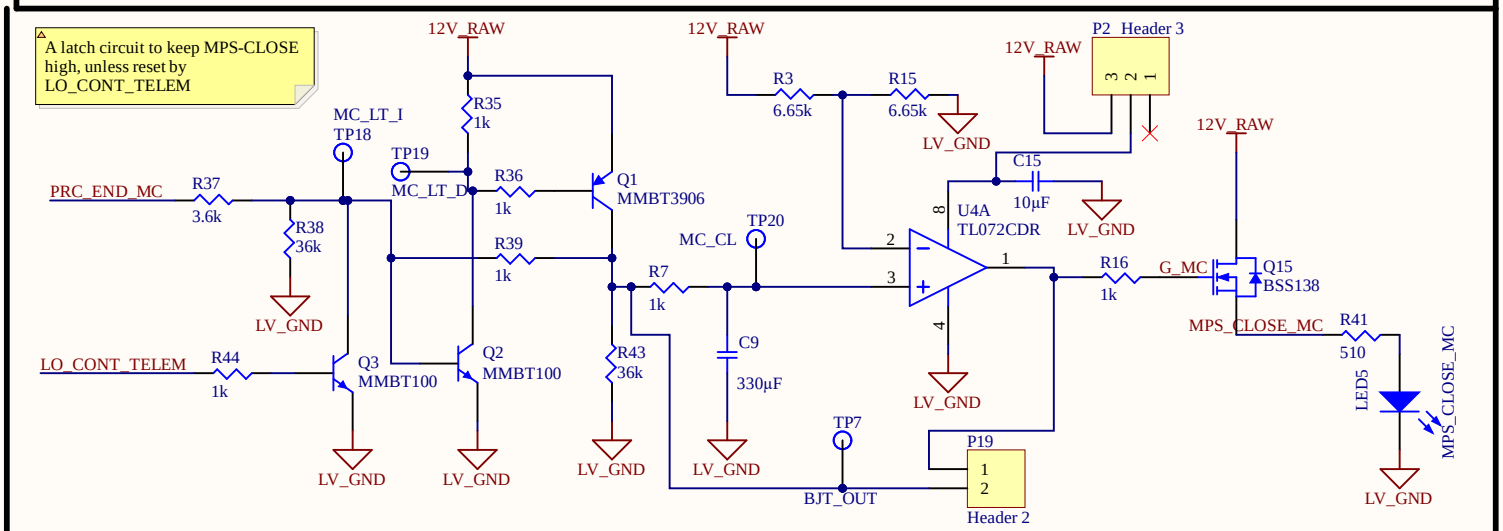
Motor Controller Precharge Relays



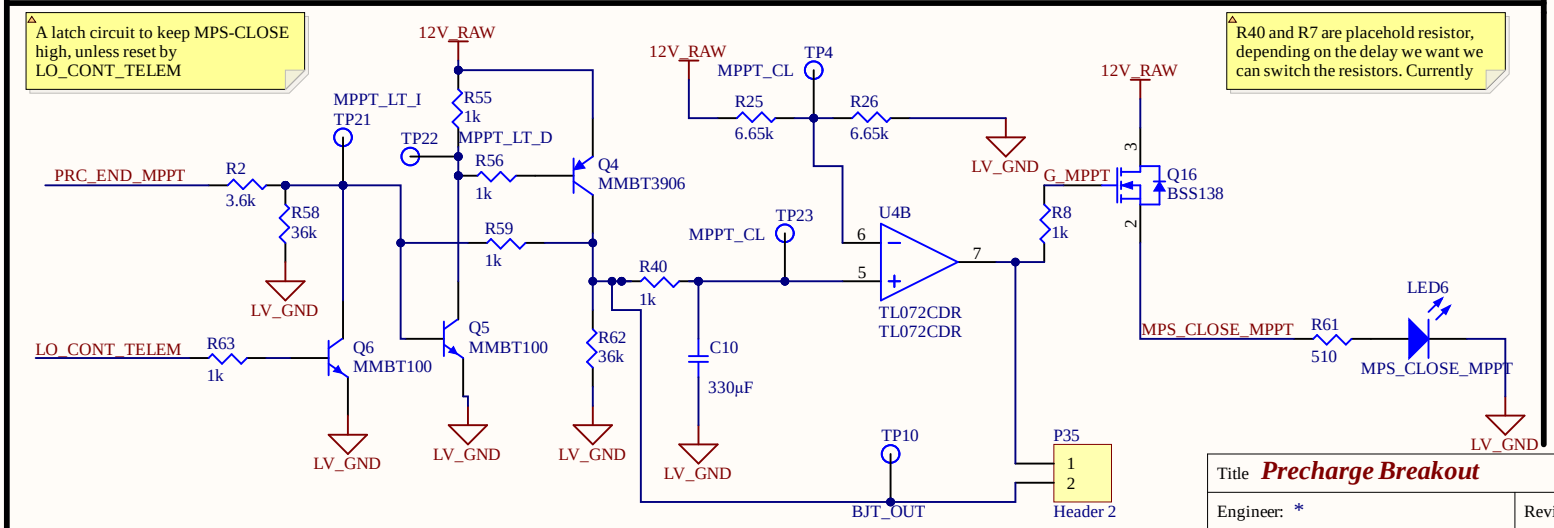
Title	***Precharge Relays***		Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer: *		Revision:*	
Date: 2023/5/24	Time: 23:34:43	Sheet 6 of 11	
File: motor_controller_relays.SchDoc			

Option #1

Motor Controller

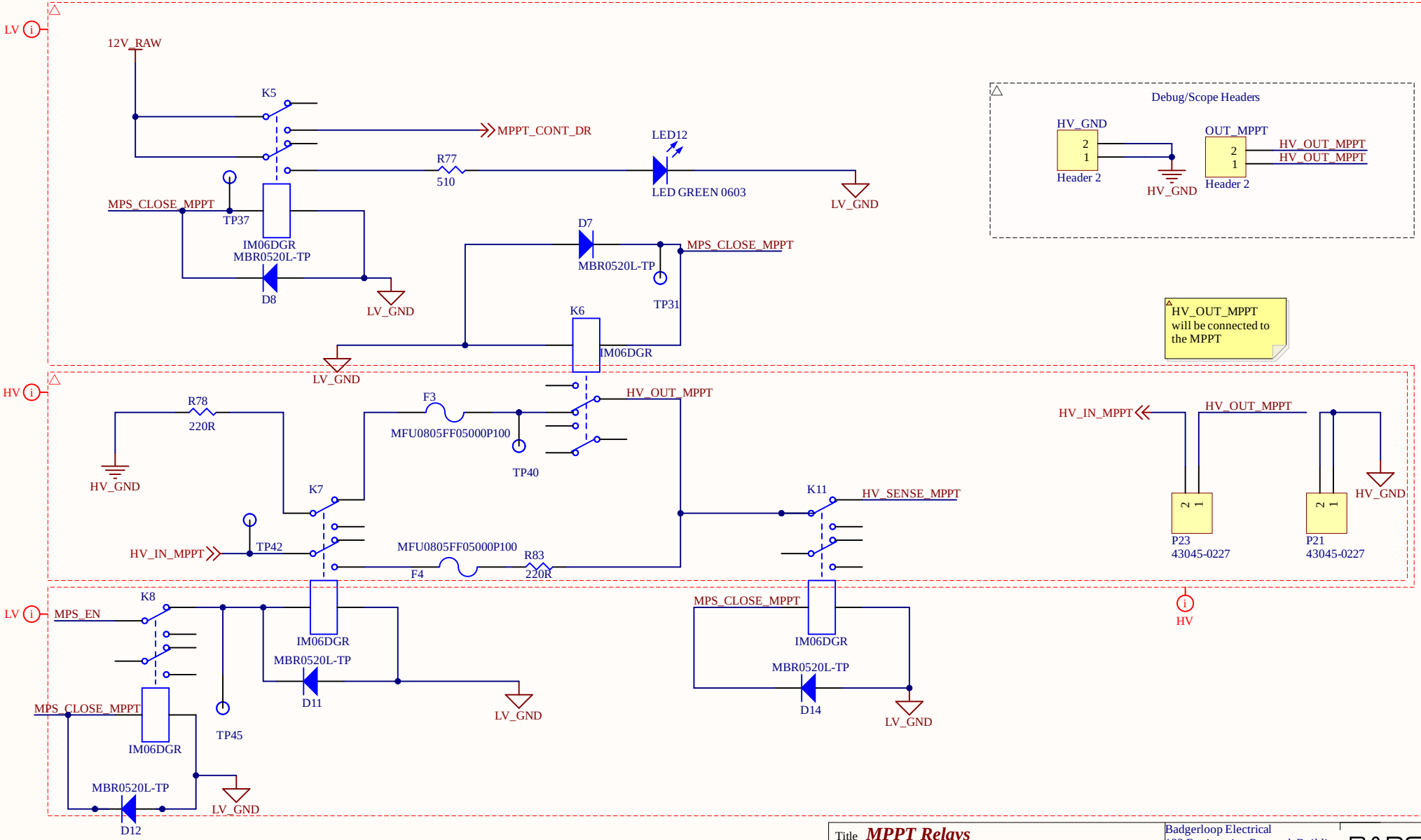


Solar Array PCB (MPPT)



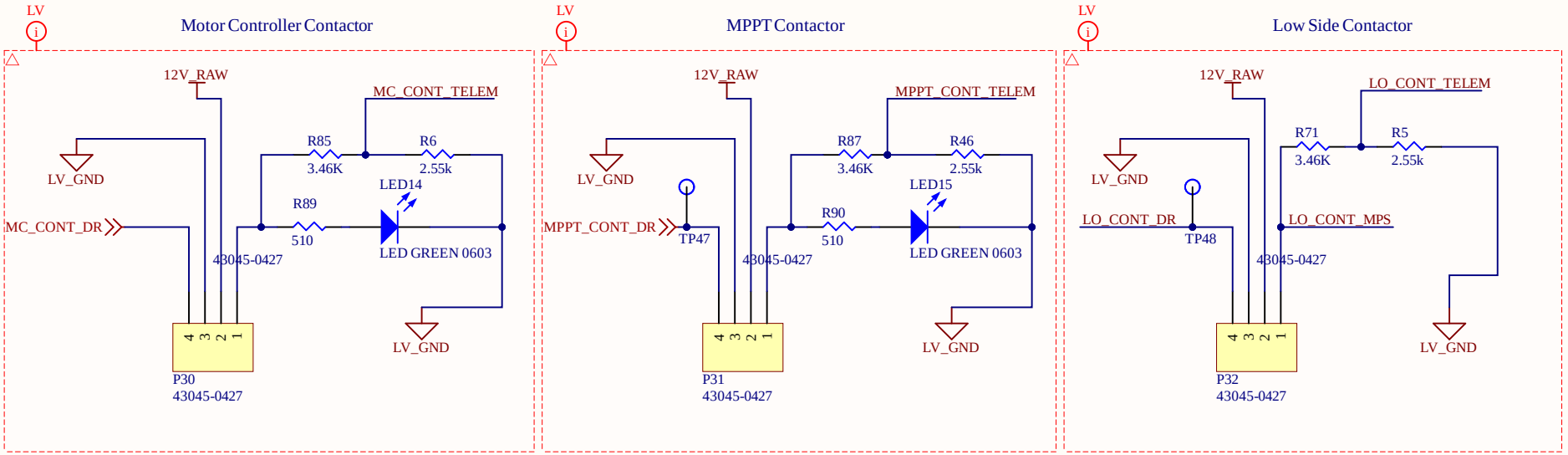
Title	***Precharge Breakout***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, WI 53706
Engineer: *	Revision:*	
Date: 2023/5/24 Time: 23:34:43	Sheet 7 of 11	
File: latch.SchDoc		

MPPT Precharge Relays



Title	***MPPT Relays***	Badgerloop Electrical 133 Engineering Research Building 1500 Engineering Drive Madison, Wi 53706
Engineer: *	Revision:*	
Date: 2023/5/24 Time: 23:34:44	Sheet 8 of 11	
File: mppt_relays.SchDoc		

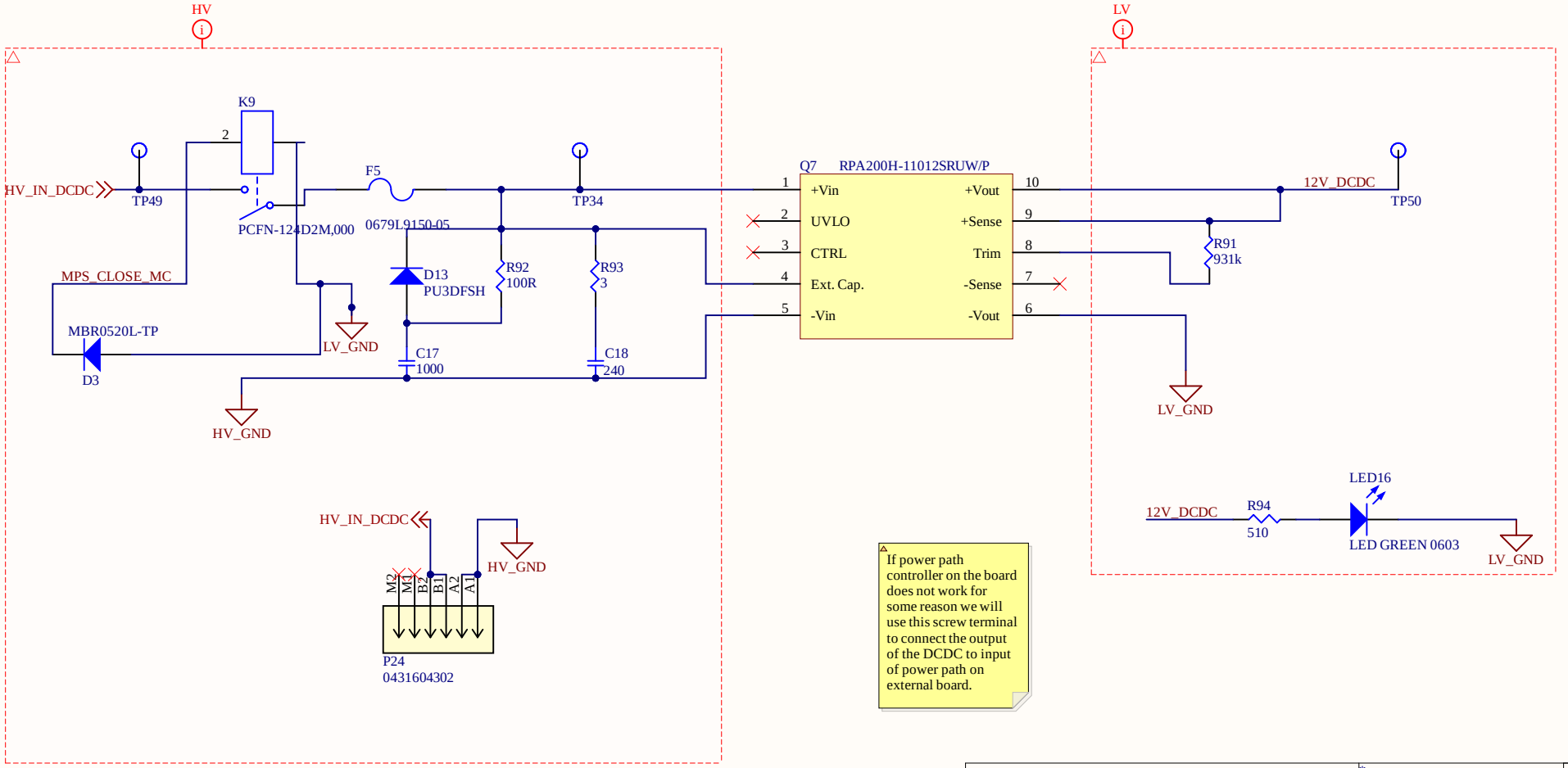
Main Power Switch



Title	***Main Power Switch***	
Engineer: *		Revision:*
Date: 2023/5/24	Time: 23:34:44	Sheet 9 of 11
File: main_power_switch.SchDoc		

BADGER LOOP

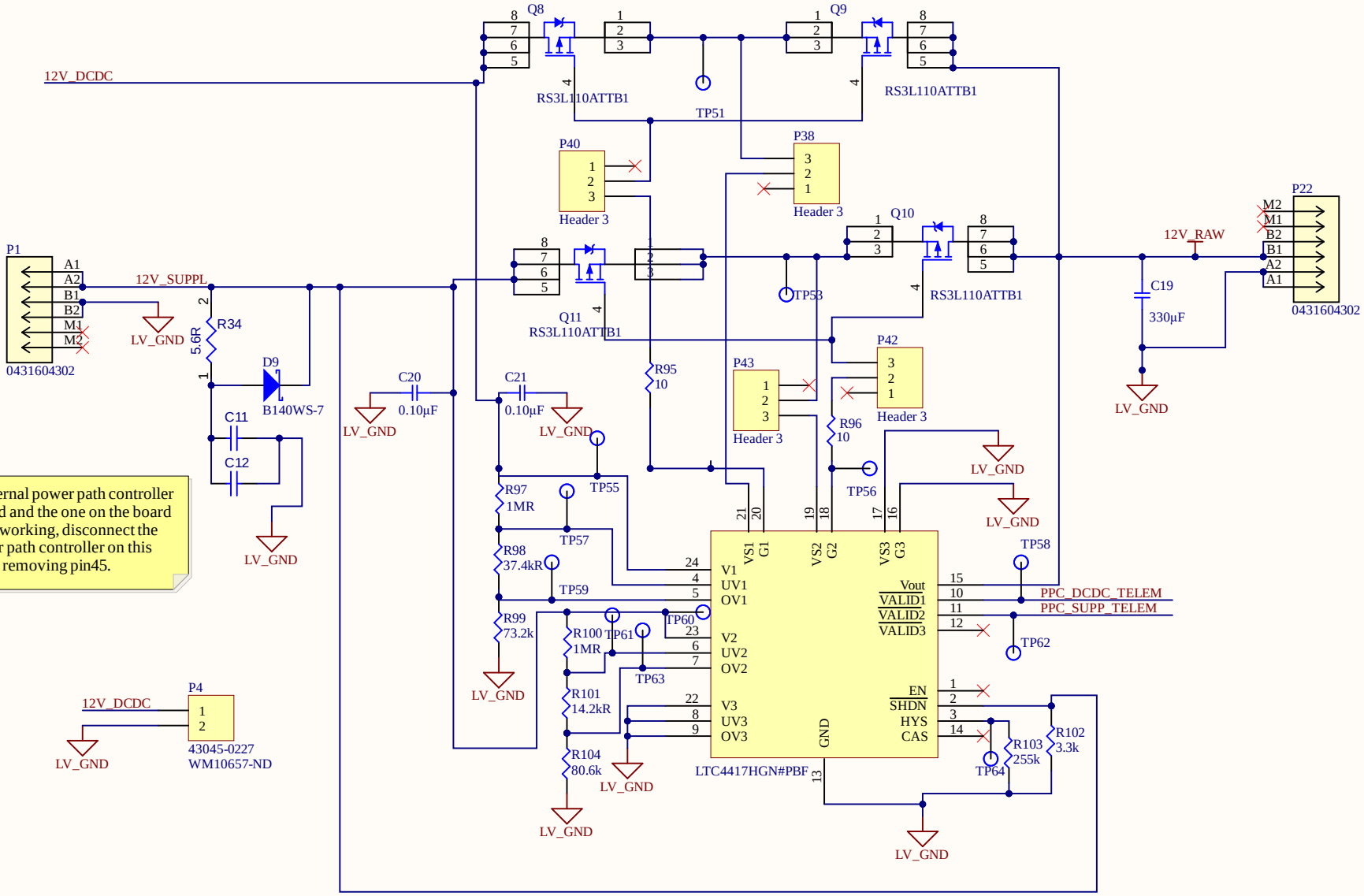
DC-DC Converter



Title *		
Engineer: *	Revision:*	
Date: 2023/5/24 Time: 23:34:45	Sheet 10 of 11	
File: dc_dc_converter.SchDoc		

BADGER LOOP

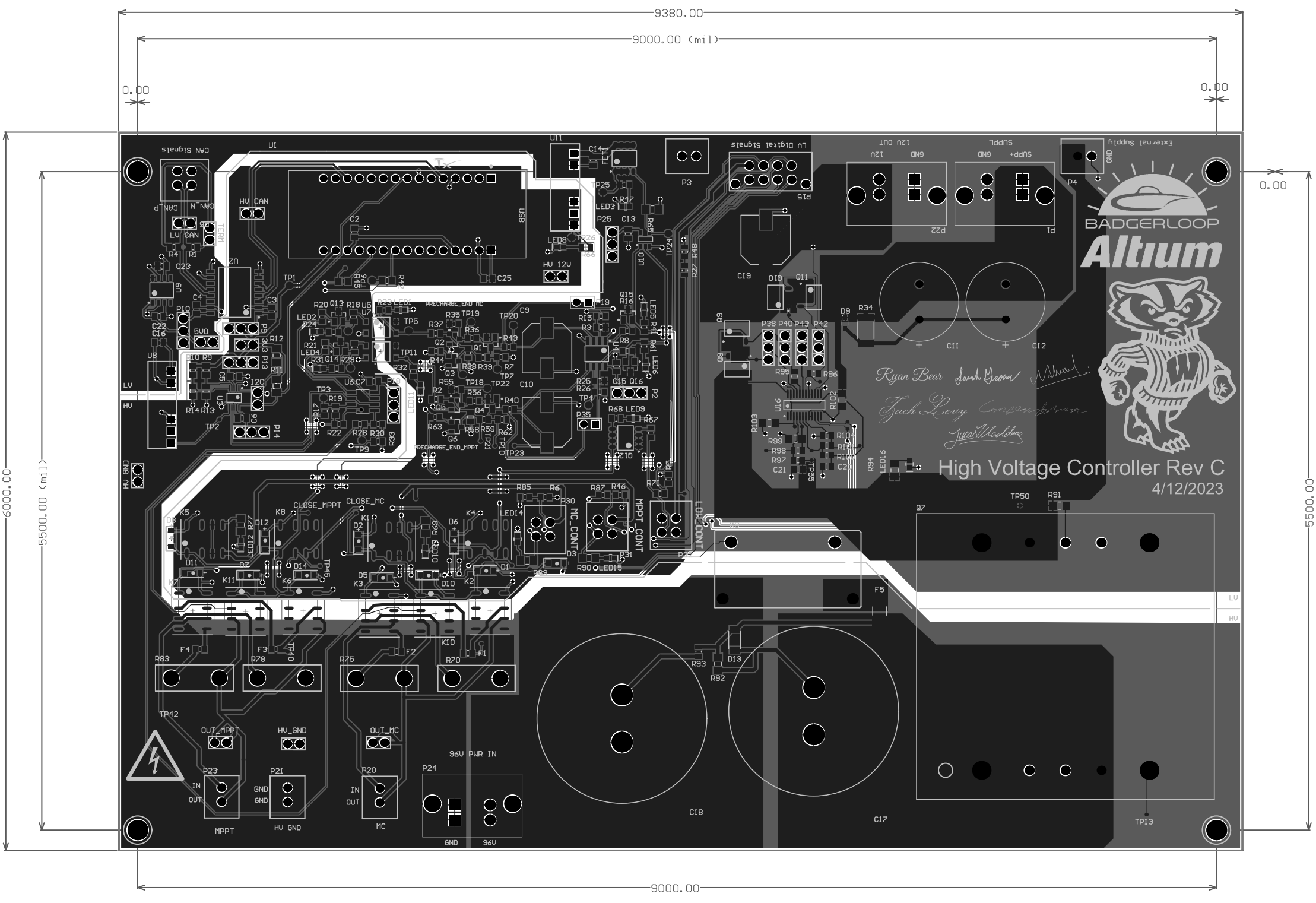
Powerpath Controller



If external power path controller is used and the one on the board is not working, disconnect the power path controller on this board removing pin45.

Title	***Power Path Controller***	
Engineer: *		Revision:*
Date: 2023/5/24	Time: 23:34:45	Sheet 11 of 11
File: powerpath_controller.SchDoc		

BADGER LOOP


9380.00
9000.00 (mil)
0.00
0.00
6000.00
5500.00 (mil)
0.00
5500.00
9000.00
BADGERLOOP
Altium
High Voltage Controller Rev C
4/12/2023
Ryan Bear
Zach Leny
CAN Signals
HV CAN
LV CAN
LV Digital Signals
External Supply
12V OUT
SUPPL
OUT_MPPT
HV_GND
OUT_MC
96V PWR IN
MPPT
HV GND
MC
GND
96V
CLOSE_MPPT
CLOSE_MC
MC_CONT
MPPT_CONT
LOG_CONT
PRECHARGE_END_MC
PRECHARGE_END_MPPT

Comment	Description	Designator	Footprint	LibRef	Quantity
Header 2	Header, 2-Pin	3V3, 5V0, HV 12V, HV CAN, HV GND, HV_GND, I2C, LV CAN, OUT_MC, OUT_MPPT, TERM	Pin Header 1x2 TH Pitch 2.54mm	CMP-002-00072-1	11
GCM21BR71A106KE22L	CAP CER 10UF 10V X7R 0805	C2, C3, C4, C5, C6, C7, C13, C14, C15, C16, C25	SMD-0805C	CMP-001-00205-1	11
GYB1E331MCW1GS	Aluminum Organic Polymer Capacitors 25V 330uf	C9, C10, C19	CAPAE110103X110N	GYB1E331MCW1GS	3
35YXJ2200M16X25	Aluminum Electrolytic Capacitor, Polarized, Aluminum (wet), 35V, 20% +Tol, 20% -Tol, 2200uF	C11, C12	35YXJ2200M16X25-Footprint-1	CMP-001-00497-1	2
1000	CAP ALUM 1000UF 20% 250V SNAP	C17	ALA7DA241DE600	ALC70A102DD250	1
ALA7DA241DE600	CAP ALUM 240UF 20% 600V SNAP	C18	ALA7DA241DE600	ALA7DA241DE600	1
0.10µF	CAP CER 0.1UF 50V X7R 0805	C20, C21	SMD-0805C	GCJ21BR71H104KA01L	2
0.1uF	Cap Ceramic 0.1uF 250V X7T 10% SMD 0805 125°C Blister Plastic T/R	C22	SMD-0805C	CGA4J3X7T2E104K125AA	1
0.33µF	CAP CER 0.33UF 100V X7R 0805	C23	SMD-0805C	GRM21AR72A334KAC5L	1
MBR0520L-TP	Rectifier Diode, Schottky, 1 Phase, 1 Element, 0.5A, 20V V(RRM), Silicon	D1, D2, D3, D5, D6, D7, D8, D10, D11, D12, D14	MBR0520LT1G - SOD123	MBR0520L-TP	11
B140WS-7	Diode Schottky 40V 1A 2-Pin SOD-323 T/R	D9	SODFL250X110-2N	CMP-004-00041-1	1
PU3DFSH	Diode Standard 200 V 3A (DC) Surface Mount SOD-128	D13	PU3DFSH	PU3DFSH	1
MFU0805FF05000P100	Electric Fuse, Very Fast Blow, 5A, 32VDC, 50A (IR), Surface Mount	F1, F2, F3, F4	SMD-0805-RES	MFU0805FF05000P100	4
0679L9150-05		F5	0679L9150-05 - fuse smd	0679L9150-05	1
RS3L110ATTB1	Transistor MOSFET P-Channel -60V ±11A 8-Pin SOP T/R	FET1, Q8, Q9, Q10, Q11, Q12	RS3L110AT	CMP-008-000012-3, CMP-008-000012-4	6
1-1462039-8	Electromechanical Relay, DPDT, 140mW (Coil), 5A (Contact), 220VDC (Contact), Random, AC/DC Output	K1, K2, K3, K4, K5, K6, K7, K8, K10, K11	1-1462039-8 - relay	1-1462039-8	10
PCFN-124D2M,000	RELAY, PCB, SPST-NO, 24VDC, 25A	K9	PCFN-124D2M,000	CMP-034-000000-1	1
LED RED	A-0603UOC	LED1, LED2, LED3, LED4, LED8, LED9, LED11	LED 0603 ORANGE	CMP-040-000018-1	7
MPS_CLOSE_MC	A-0603UOC	LED5	LED 0603 ORANGE	CMP-040-000018-1	1
MPS_CLOSE_MPPT	A-0603UOC	LED6	LED 0603 ORANGE	CMP-040-000018-1	1
LED GREEN 0603		LED10, LED12, LED14, LED15, LED16	LED 0603 GREEN	LED GREEN 0603	5
4-40 Mount Hole		MH1, MH2, MH3, MH4	MH	CMP-008-000006-1	4
0431604302	Rectangular Power Connector, 2 Contact(s), Male, Solder Terminal	P1, P22, P24	CON_431604302_MOL	CMP-008-000054-1	3
Header 3	Header, 3-Pin	P2, P9, P10, P13, P14, P18, P25, P38, P40, P42, P43	Pin Header 1x3 TH Pitch 2.54mm	CMP-002-00073-1	11
43045-0227	Board Connector, 2 Contact(s), 2 Row(s), Male, Straight, Solder Terminal, Locking, Black Insulator, Receptacle	P3, P4, P20, P21, P23	43045-0277	43045-0227, CMP-002-00096-1	5
43045-0427	Board Connector, 4 Contact(s), 2 Row(s), Male, Straight, Solder Terminal, Locking, Black Insulator, Receptacle	P5, P30, P31, P32	430450427	43045-0427	4
0430450827	CONN HEADER VERT 8POS 3MM	P15	0430450827	CMP-002-00093-1	1
Header 2	Header, 2-Pin	P19, P35	HDR1X2	Header 2	2
MMBT3906	PNP General-Purpose Amplifier, 40 V, 0.2 A, -55 to 150 degC, 3-Pin SOT23, RoHS, Tape and Reel	Q1, Q4	FAIR-SOT23-3_V	CMP-013-00008-2	2
MMBT100	Small Signal Bipolar Transistor, 0.5A I(C), 45V V(BR)CEO, 1-Element, NPN, Silicon	Q2, Q3, Q5, Q6	SOTFL103P240X110-3N	CMP-040-000001-1	4
RPA200H-11012SRUW	DC DC CONVERTER 12V 200W	Q7	RPA200H	RPA200H-11012SRUW	1
BSS138	N-Channel Logic Level Enhancement Mode Field Effect Transistor, 220 mA, 50 V, -55 to 150 degC, 3-Pin SOT-23, RoHS, Tape and Reel	Q13, Q14, Q15, Q16	FAIR-SOT23-3_V	CMP-013-00021-4	4
ERJ-6ENF60R4V	RES SMD 60.4 OHM 1% 1/8W 0805	R1, R4	SMD-0805-RES	CMP-009-01480-1	2
ERJ-6ENF3601V	RES SMD 3.6K OHM 1% 1/8W 0805	R2, R37	SMD-0805-RES	CMP-009-01342-1	2
6.65k	RES SMD 6.65K OHM 1% 1/8W 0805	R3, R15, R25, R26	SMD-0805-RES	ERJ-6ENF6651V	4
2.55k	RES SMD 2.55K OHM 1% 1/8W 0805	R5, R6, R46	SMD-0805-RES	ERJ-6ENF2551V	3
ERJ-P06F1001V	RES SMD 1K OHM 1% 1/2W 0805	R7, R8, R16, R18, R29, R35, R36, R39, R40, R44, R55, R56, R59, R63, R67	SMD-0805-RES	CMP-009-02659-1	15
Resistor 0R +/- 5% 0805 125 mW	Chip Resistor, 0 Ohm, 0.125 W, -55 to 155 degC, 0805 (2012 Metric)	R9, R10, R13, R14, R42, R45	RESC2013X60X35ML10T20	CMP-009-00007-5	6
ERJ-P08J103V	RES SMD 10K OHM 5% 2/3W 1206	R11, R12	SMD-1206-RES	CMP-009-00681-1	2
ERJ-6GEYJ752V	RES SMD 7.5K OHM 5% 1/8W 0805	R17, R19, R22, R28, R30, R33	SMD-0805-RES	CMP-009-01751-1	6
10	RES SMD 10 OHM 5% 1/8W 0805	R20, R21, R95, R96	SMD-0805-RES	ERJ-6GEYJ100V	4
ERJ-P06J511V	RES SMD 510 OHM 5% 1/2W 0805	R23, R24, R31, R32, R41, R47, R61, R66, R68	SMD-0805-RES	CMP-009-00645-1	9
ERJ-6ENF4702V	RES SMD 47K OHM 1% 1/8W 0805	R27	SMD-0805-RES	CMP-009-01413-1	1
5.6R	Fixed Resistor, Metal Glaze/thick Film, 1W, 5.6ohm, 200V, 5% +/-Tol, 400ppm/Cel, Surface Mount, 2512	R34	FP-RMCF2512-IPC_C	CMP-009-02795-1	1
ERJ-6ENF3602V	RES SMD 36K OHM 1% 1/8W 0805	R38, R43, R58, R62	SMD-0805-RES	CMP-009-01343-1	4
ERJ-6ENF1502V	RES SMD 15K OHM 1% 1/8W 0805	R48	SMD-0805-RES	CMP-009-01105-1	1
ERJ-8ENF1002V	RES SMD 10K OHM 1% 1/4W 1206	R65	SMD-1206-RES	CMP-009-01876-1	1
RMCF1206FT510R	Fixed Resistor, Metal Glaze/thick Film, 0.25W, 510ohm, 200V, 1% +/-Tol, 100ppm/Cel, Surface Mount, 1206	R69, R77, R89, R90, R94	SMD-1206-RES	RMCF1206FT510R	5
AP101220RJ	Fixed Resistor, 100W, 220ohm, 700V, 5% +/-Tol, 100ppm/Cel, Through Hole Mount	R70, R75, R78, R83	TO-247-2	AP101220RJ	4
3.46K	Fixed Resistor, Metal Glaze/thick Film, 0.125W, 3460ohm, 150V, 1% +/-Tol, 100ppm/Cel, Surface Mount, 0805	R71, R85, R87	SMD-0805-RES	CRCW08053K46FKTA	3
931k	Fixed Resistor, Metal Glaze/thick Film, 0.5W, 470ohm, 200V, 1% +/-Tol, 100ppm/Cel, Surface Mount, 1206	R91	SMD-1206-RES	ERJ-8ENF9313V	1
100R	Fixed Resistor, Thin Film, 1W, 100ohm, 200V, 0.5% +/-Tol, 25ppm/Cel, Surface Mount, 1206	R92	SMD-1206-RES	HRG3216P-1000-D-T1	1
3	Fixed Resistor	R93	SMD-0805-RES	PCAN0805K3R00FST5	1
1MR	RES 1M OHM 1% 1/8W 0805	R97, R100	SMD-0805-RES	CRCW08051M00FKEAC	2
37.4kR	RES SMD 37.4K OHM 1% 1/8W 0805	R98	SMD-0805-RES	CRCW080537K4FKEA	1
73.2k	RES SMD 73.2K OHM 1% 1/4W 1206	R99	SMD-1206-RES	ERJ-8ENF7322V	1
14.2kR	RES 14.2K OHM 0.1% 1/5W 0805	R101	SMD-0805-RES	TNPW080514K2BEEA	1
3.3k	RES SMD 3.3K OHM 1% 1/4W 1206	R102	SMD-1206-RES	ERJ-8ENF3301V	1
255k	RES SMD 255K OHM 1% 1/4W 1206	R103	SMD-1206-RES	ERJ-8ENF2553V	1
80.6k	RES SMD 80.6K OHM 1% 1/8W 0805	R104	SMD-0805-RES	ERJ-6ENF8062V	1
D3V3	SMD TEST POINT	TP1	Test Point	CMP-039-000000-1	1
HV12	SMD TEST POINT	TP2, TP26	Test Point	CMP-039-000000-1	2
MC_OP	SMD TEST POINT	TP3	Test Point	CMP-039-000000-1	1
MPPT_CL	SMD TEST POINT	TP4, TP23	Test Point	CMP-039-000000-1	2
MC_PRC	SMD TEST POINT	TP5	Test Point	CMP-039-000000-1	1
MC_ADC	SMD TEST POINT	TP6	Test Point	CMP-039-000000-1	1
BJT_OUT	SMD TEST POINT	TP7, TP10	Test Point	CMP-039-000000-1	2
MC_TH	SMD TEST POINT	TP8	Test Point	CMP-039-000000-1	1
MPPT_OP	SMD TEST POINT	TP9	Test Point	CMP-039-000000-1	1
MPPT_PRC	SMD TEST POINT	TP11	Test Point	CMP-039-000000-1	1
MPPT_ADC	SMD TEST POINT	TP12	Test Point	CMP-039-000000-1	1
MPPT_HV	SMD TEST POINT	TP13, TP15	Test Point	CMP-039-000000-1	2
MPPT_TH	SMD TEST POINT	TP14	Test Point	CMP-039-000000-1	1
MC_LT_I	SMD TEST POINT	TP18	Test Point	CMP-039-000000-1	1
MC_LT_D	SMD TEST POINT	TP19	Test Point	CMP-039-000000-1	1
MC_CL	SMD TEST POINT	TP20	Test Point	CMP-039-000000-1	1
MPPT_LT_I	SMD TEST POINT	TP21	Test Point	CMP-039-000000-1	1
MPPT_LT_D	SMD TEST POINT	TP22	Test Point	CMP-039-000000-1	1
12V_OFF	SMD TEST POINT	TP24	Test Point	CMP-039-000000-1	1
LV_12	SMD TEST POINT	TP25	Test Point	CMP-039-000000-1	1
TP	SMD TEST POINT	TP27, TP28, TP30, TP31, TP32, TP34, TP35, TP36, TP37, TP40, TP42, TP45, TP47, TP48, TP49, TP50, TP51, TP53, TP55, TP56, TP57, TP58, TP59, TP60, TP61, TP62, TP63, TP64	Test Point	TP	28
NUCLEO-L432KC	BOARD NUCLEO STM32F303K8T6	U1	NUCLEO-L432KC	CMP-020-000017-1	1
ISO1050DWR	IC TXRX/ISO HALF 1/1 16SOIC	U2	IL 41050TE	CMP-031-00010-1	1
DS3502U+T&R	Digital Potentiometer, 1 Func, 10000ohm, 2-wire Serial Control Interface, 128 Positions, PDSO10	U3	MAXM-U10+2_L	CMP-008-000013-1	1
TL072CDR	IC OPAMP JFET 3MHZ 8SOIC	U4	SOP127P600X175-8N	CMP-014-00006-1	1
IS181D	Transistor Output Optocoupler	U5, U7	IS181D	CMP-020-000001-1	2
TLV3702CD	Comparator, 2 Func, 7000uV Offset-Max, 240000ns Response Time, CMOS, PDSO8	U6	TLV3702CD-Footprint-1	CMP-014-00010-1	1
TMV1212S	DC-DC Regulated Power Supply Module, 1 Output, 1W, Hybrid	U8, U11	TMV1212S-Footprint-1	CMP-008-000009-3	2
UA78L05ACDR	Fixed Positive Standard Regulator, 5VBIPolar, PDSO8	U9	D0008A_L	CMP-031-00025-1	1
BU4S81G2-TR	AND Gate, 4000/14000/40000 Series, 1-Func, 2-Input, CMOS, PDSO5	U10	BU4S81G2	CMP-017-000001-1	1
LTC4417HGN#PBF	Power Supply Support Circuit, Adjustable, 3 Channel, CMOS, PDSO24	U16	LT-GN-24_L	CMP-008-000010-2	1