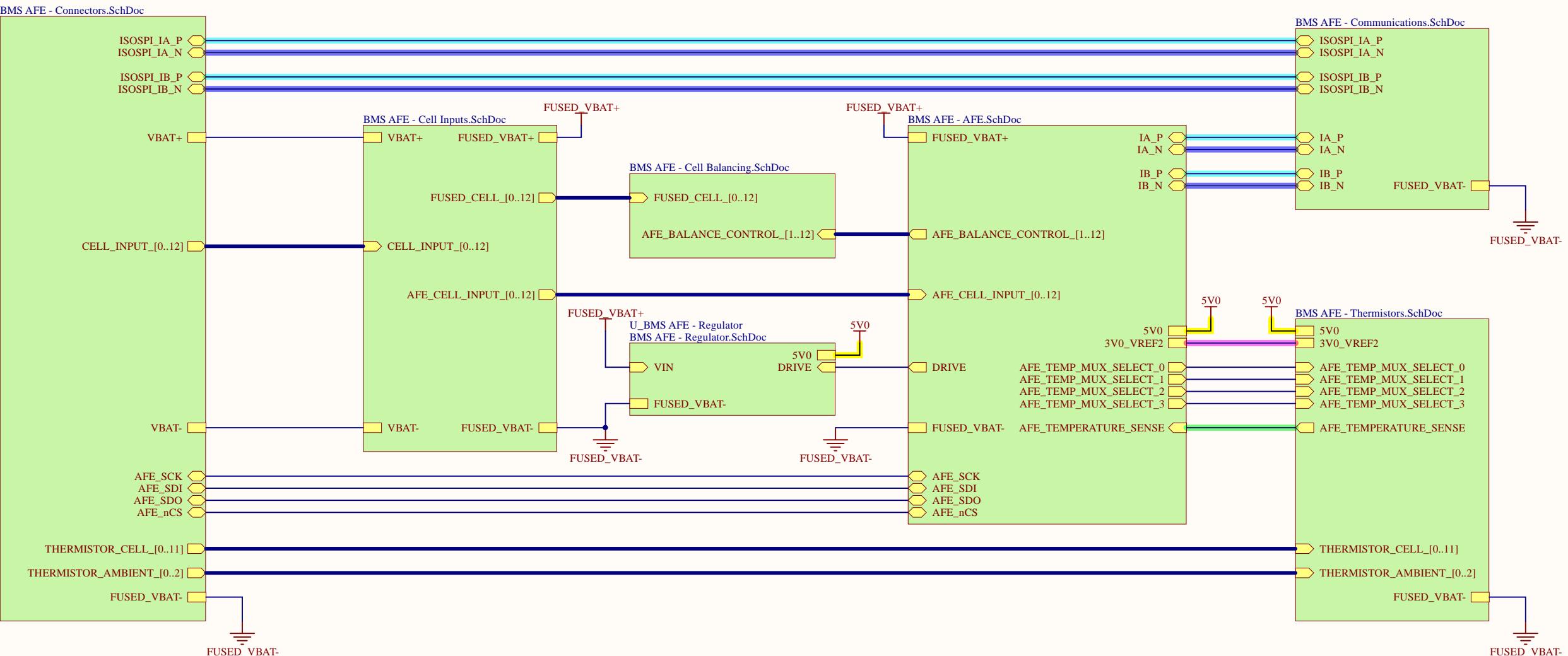


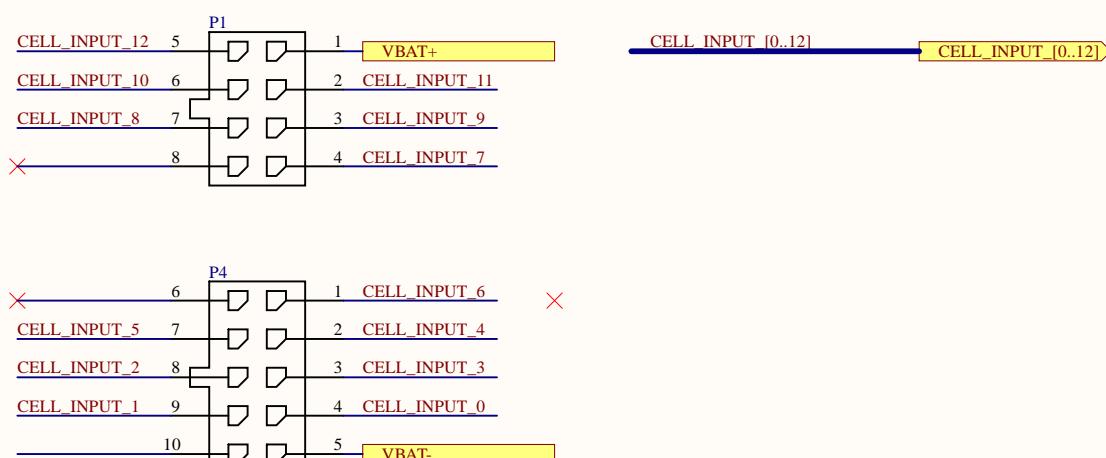
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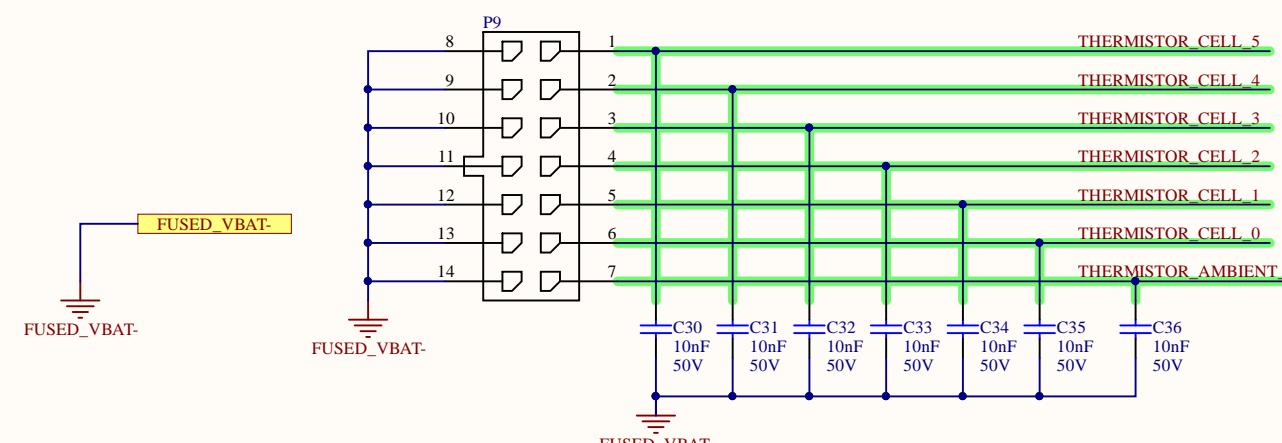
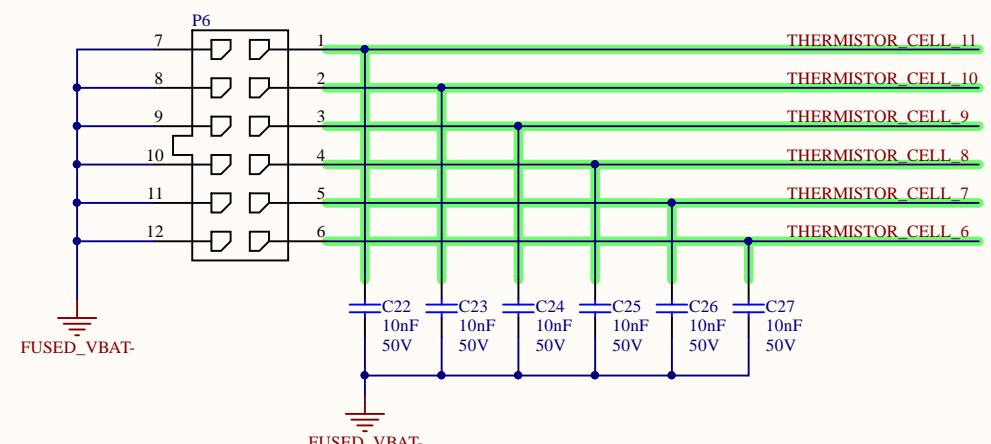
PROJECT	BMS_AFE.PjPcb	
DOCUMENT	BMS AFE - Top Sheet.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Taiping Li	REVISION 5.0
LAST MODIFIED	2019-03-18	SHEET 1 OF 7



Cell Inputs

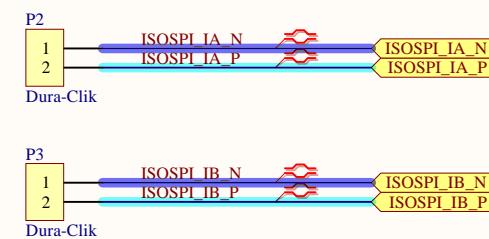


Cell Thermistors

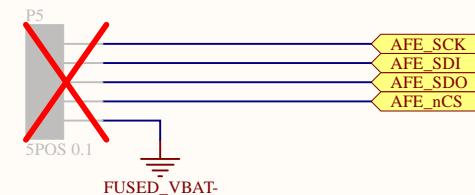


THERMISTOR_CELL [0..11] → THERMISTOR_CELL [0..11]
 THERMISTOR_AMBIENT [0..2] → THERMISTOR_AMBIENT [0..2]

isoSPI Connectors

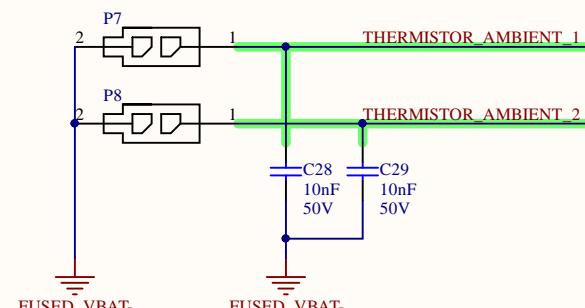


Optional 4-wire SPI

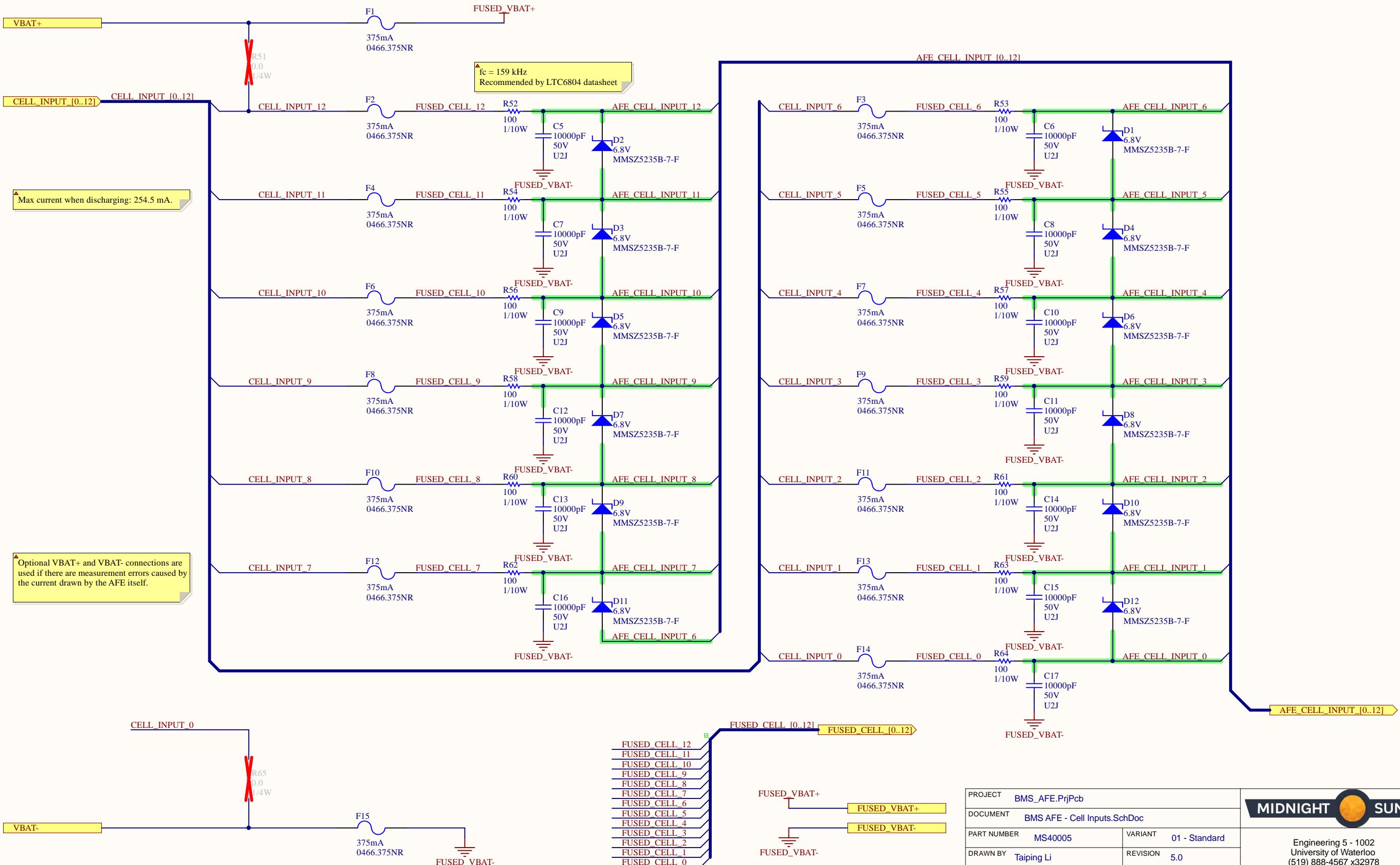


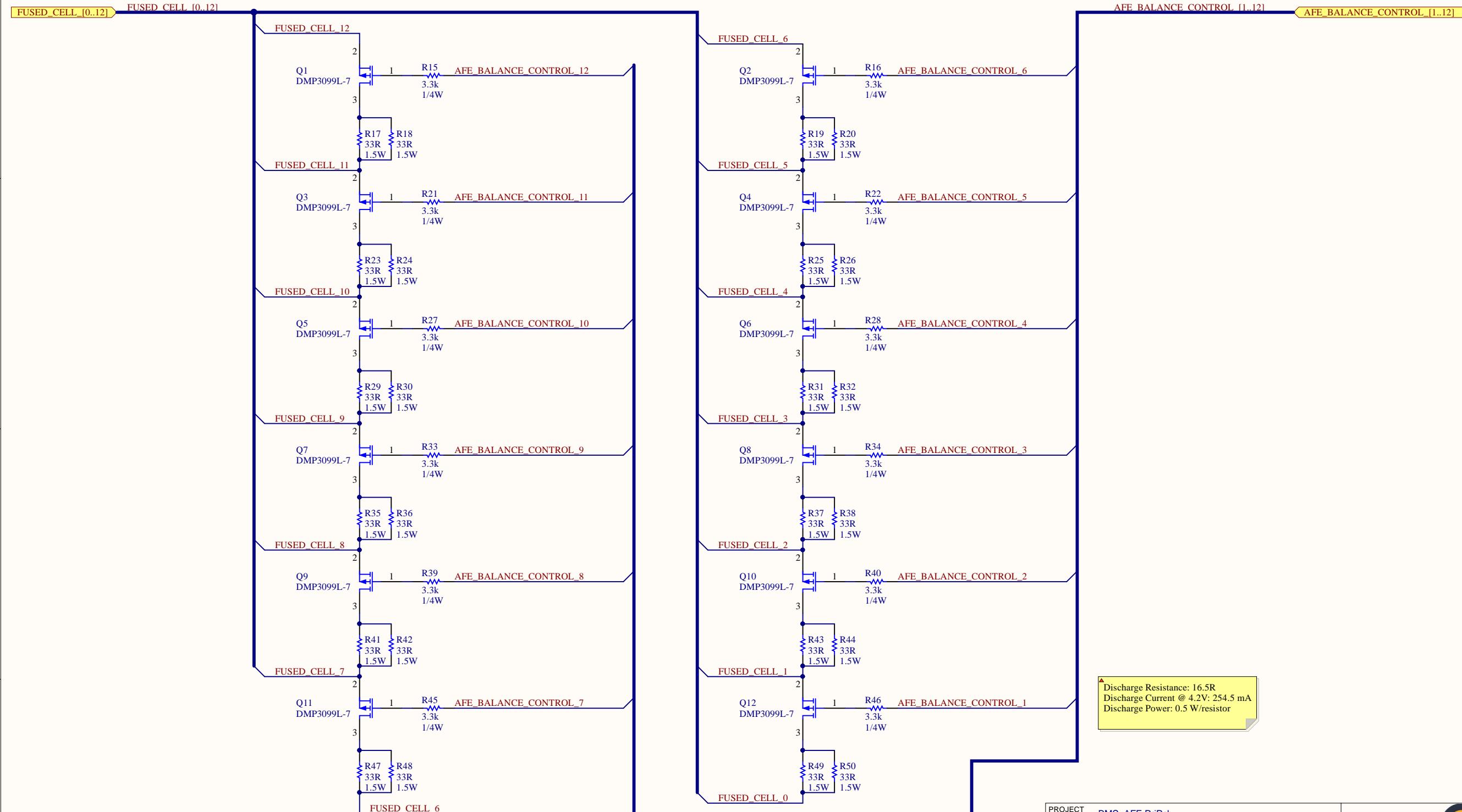
▲ Use variant Debug - SPI and solder on a 0.1" header to talk to the LTC6804 via SPI.
Otherwise, communication should be isoSPI.

Ambient Thermistors



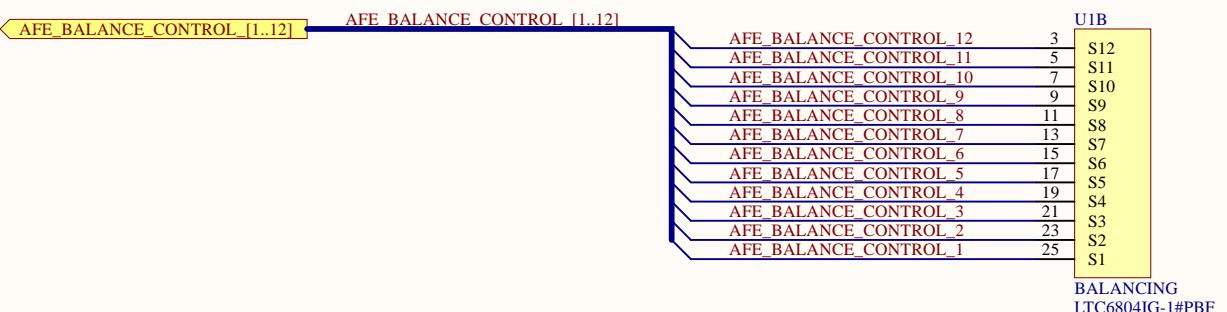
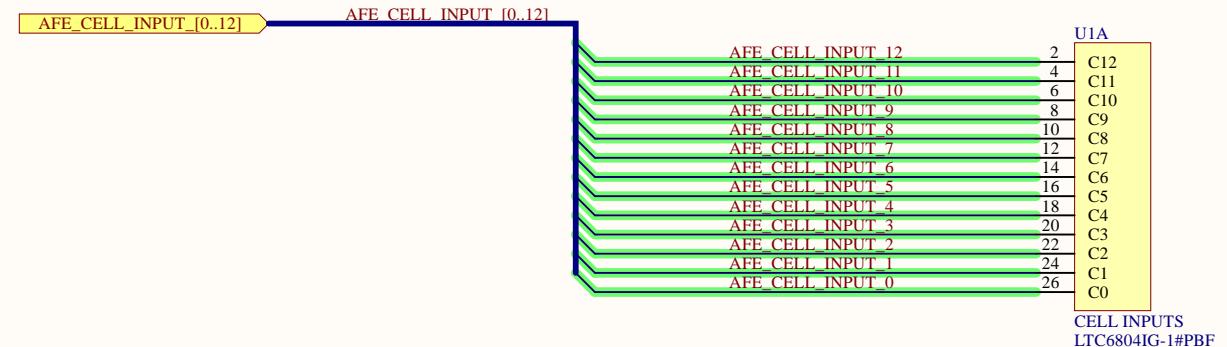
PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Connectors.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Taiping Li	REVISION 5.0
LAST MODIFIED	2019-03-18	SHEET 2 OF 7



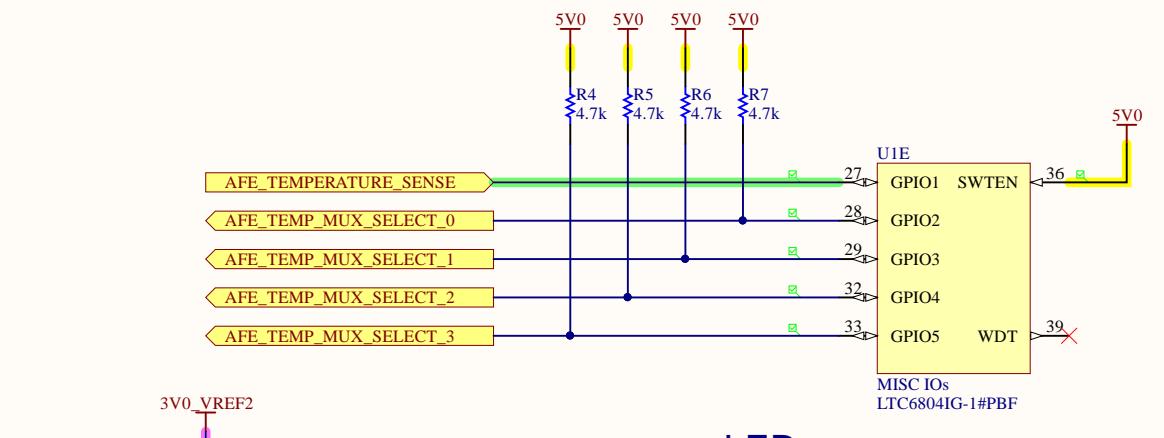


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Cell Balancing.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Taiping Li	REVISION 5.0
LAST MODIFIED	2019-03-18	SHEET 4 OF 7

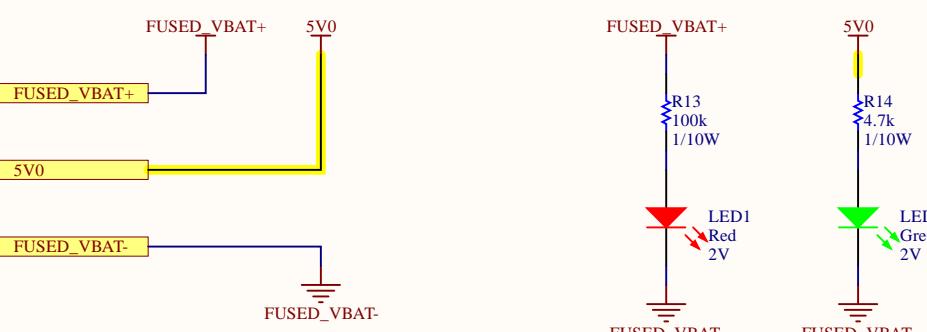
Cell & Balancing Inputs



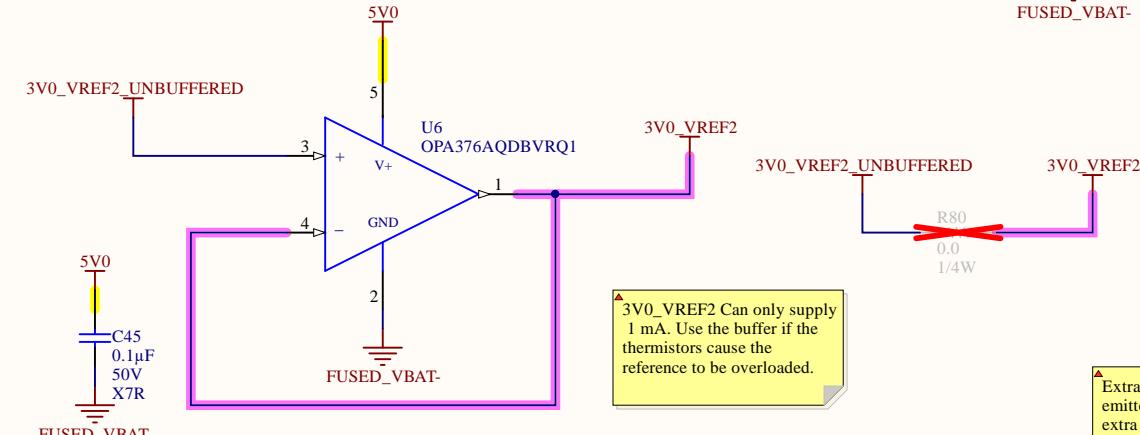
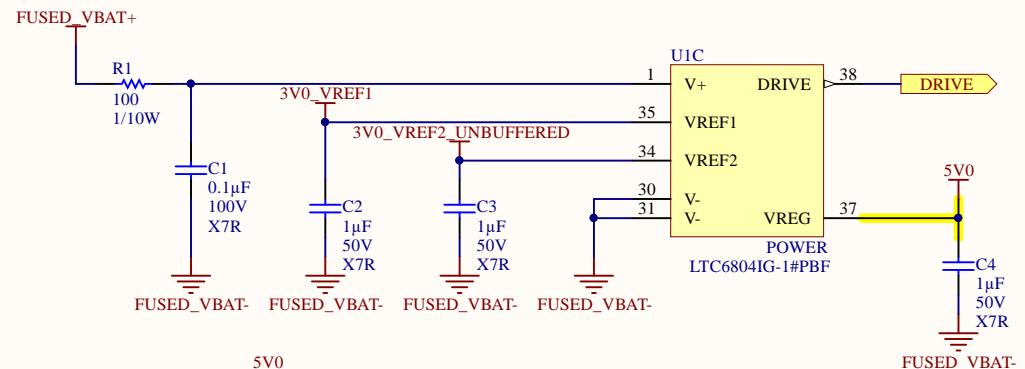
GPIOs



LEDs

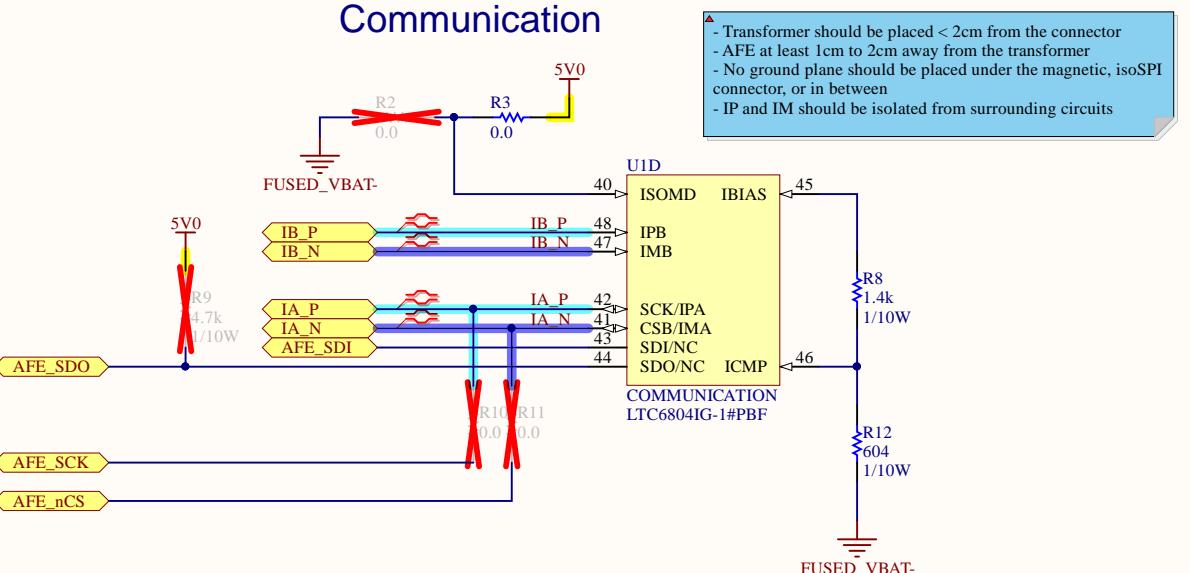


Power



Extra 1uF capacitor near the emitter of the NPN incase extra capacitance is needed. LTC datasheet suggested 1uF total

Communication



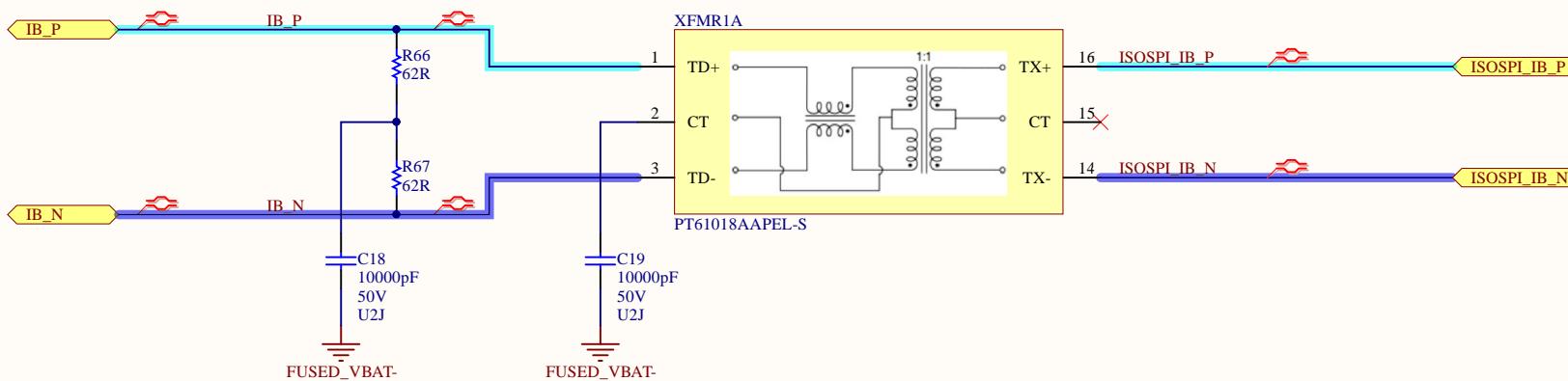
- Transformer should be placed < 2cm from the connector
- AFE at least 1cm to 2cm away from the transformer
- No ground plane should be placed under the magnetic, isoSPI connector, or in between
- IP and IM should be isolated from surrounding circuits

isoSPI:
Ib = 1 mA
Ibias = 20 mA
Vicmp = 602 mV
Pulses with amplitudes greater than 602 mV/2 = ± 301 mV will be detected

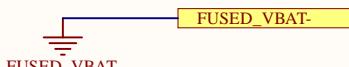
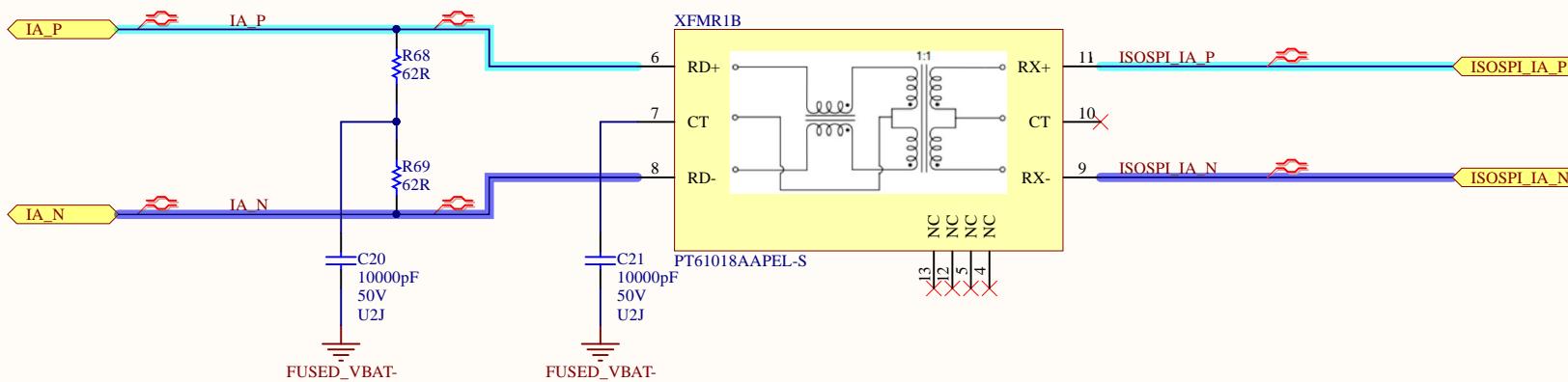
PROJECT	BMS_AFE.PrjPcb
DOCUMENT	BMS AFE - AFE.SchDoc
PART NUMBER	MS40005
DRAWN BY	Taiping Li
LAST MODIFIED	2019-03-18
VARIANT	01 - Standard
REVISION	5.0
SHEET	5 OF 7

isoSPI

MASTER - TO NEXT AFE

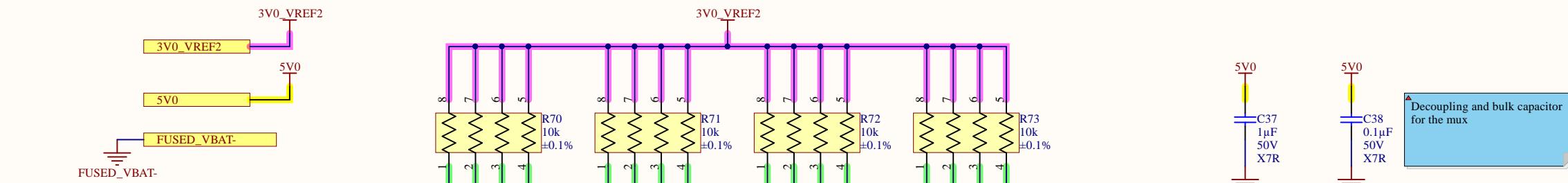


SLAVE - FROM LTC6820

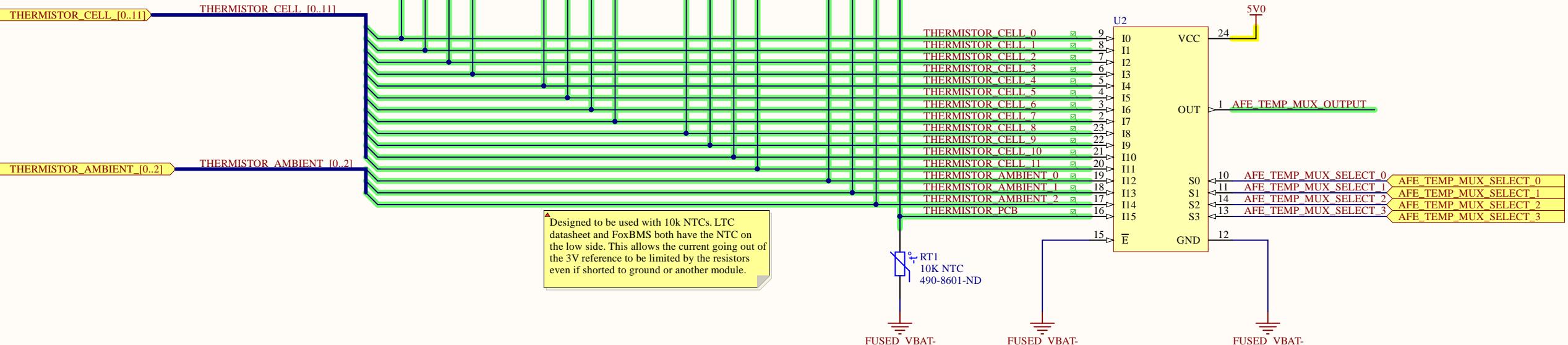


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Communications.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Taiping Li	REVISION 5.0
LAST MODIFIED	2019-03-18	SHEET 6 OF 7

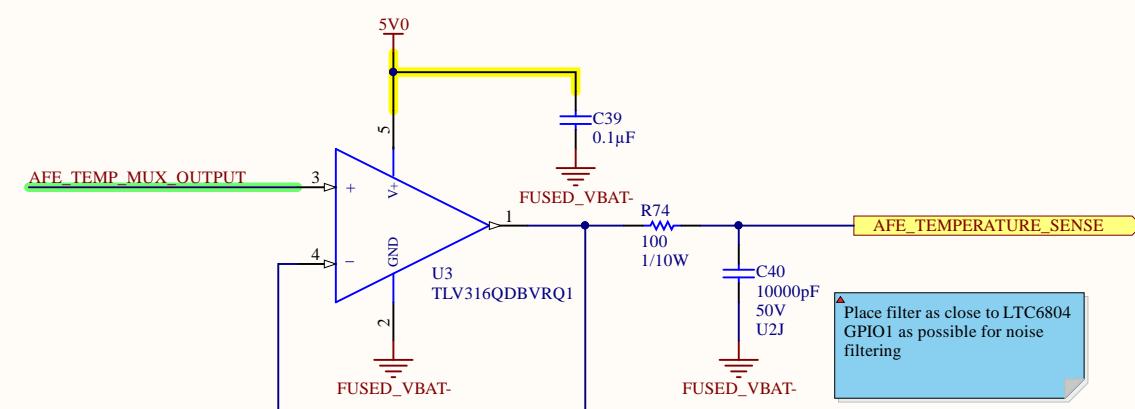
A



B



C

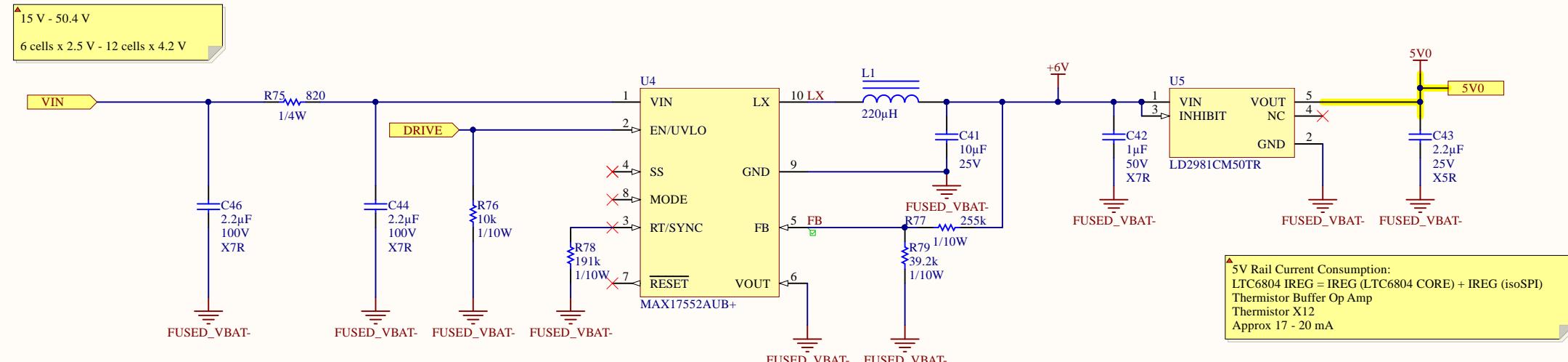


D

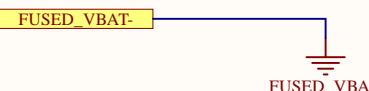
PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Thermistors.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Taiping Li	REVISION 5.0
LAST MODIFIED	2019-03-18	SHEET 7 OF 7



A



B



C

D

PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	Title	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Taiping Li	REVISION 5.0
LAST MODIFIED	2019-03-18	SHEET * OF *



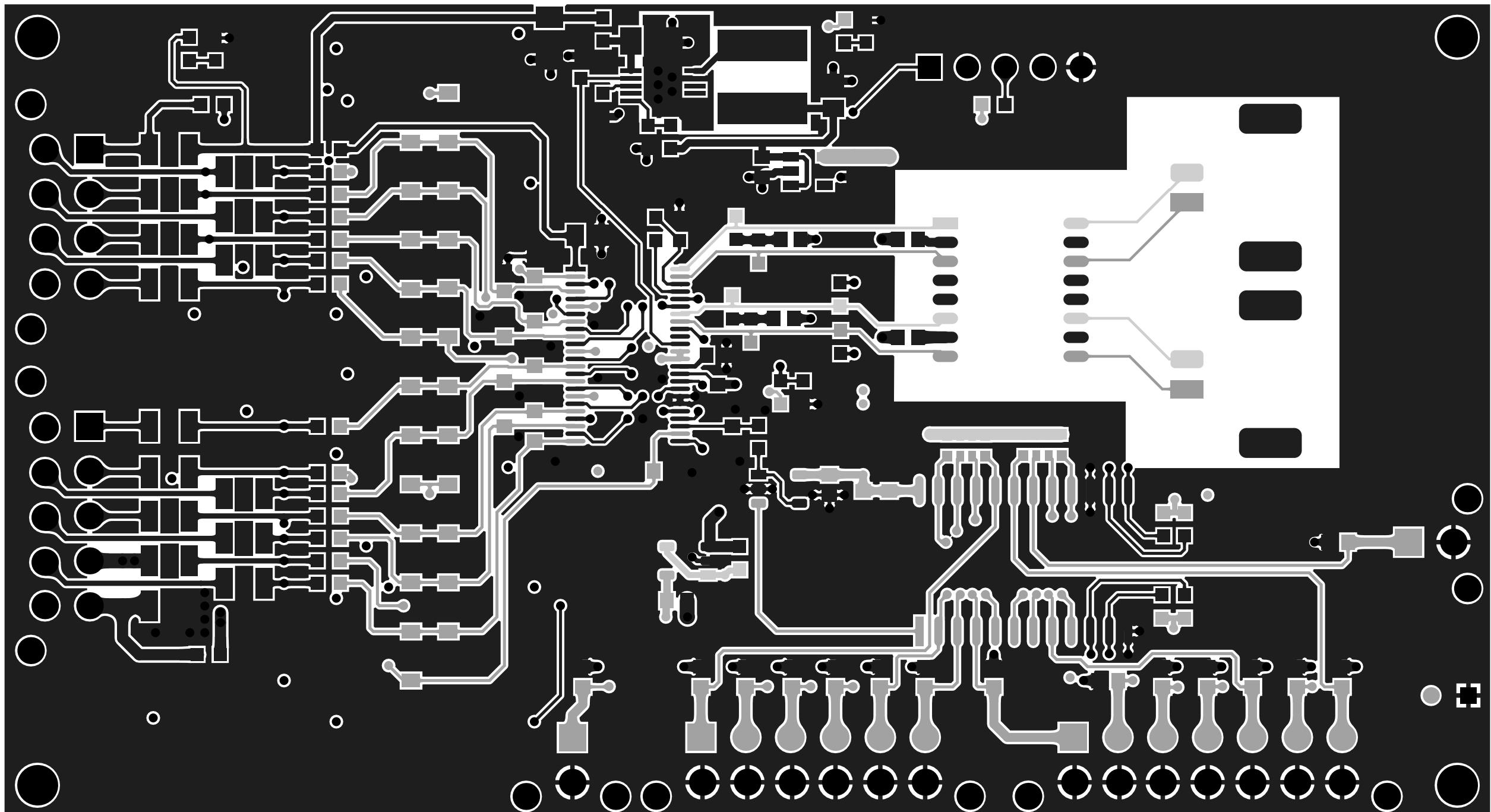
Engineering 5 - 1002
 University of Waterloo
 (519) 888-4567 x32978
 hardware@uwmidnsun.com

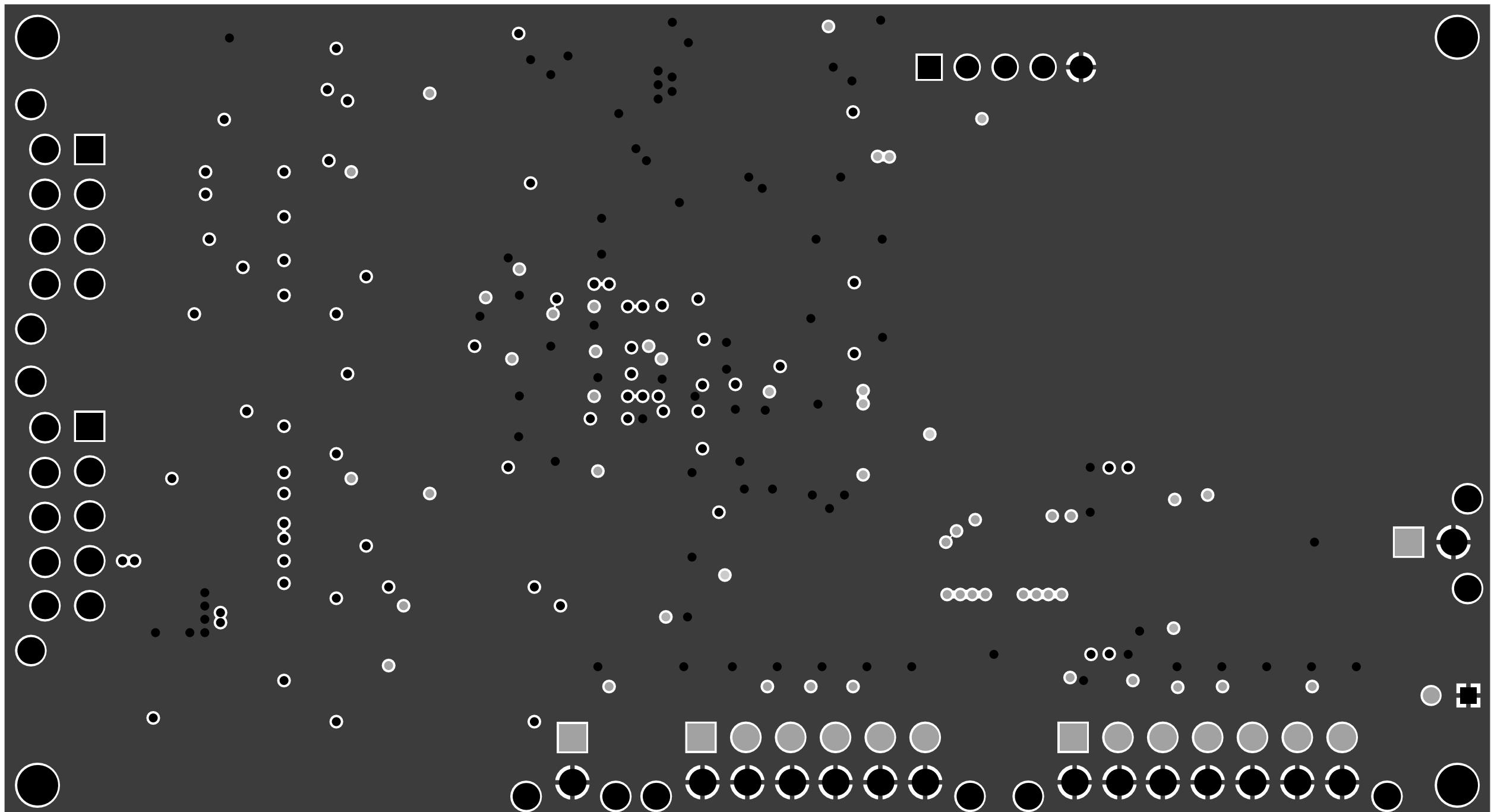
Bill of Materials

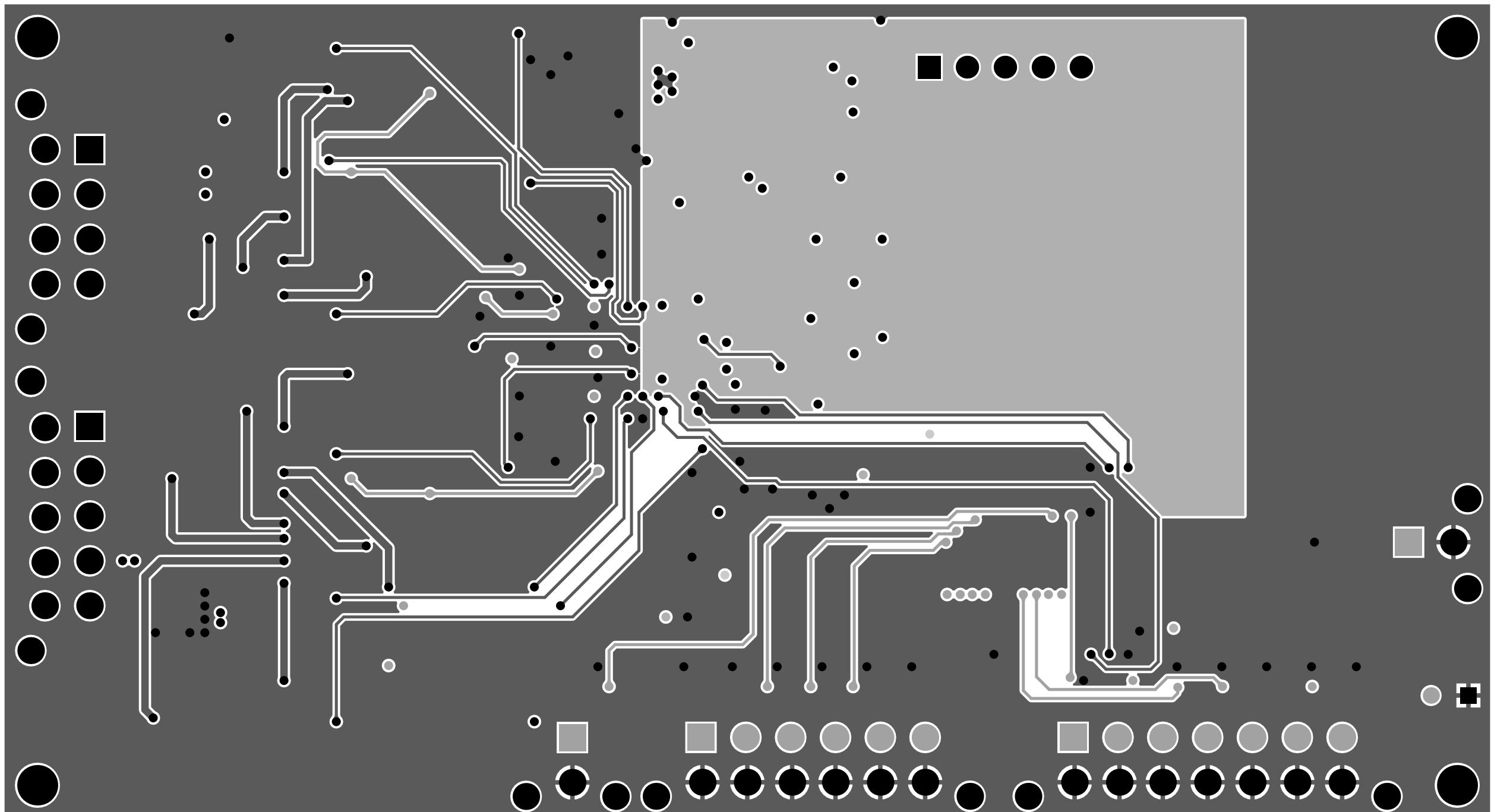
Project:	BMS_AFE.PrjPcb
Revision:	5
Project Lead:	Taiping Li
Generated On:	2019-03-18 10:58
Production Quantity:	1
Currency	CAD
Total Parts Count:	177



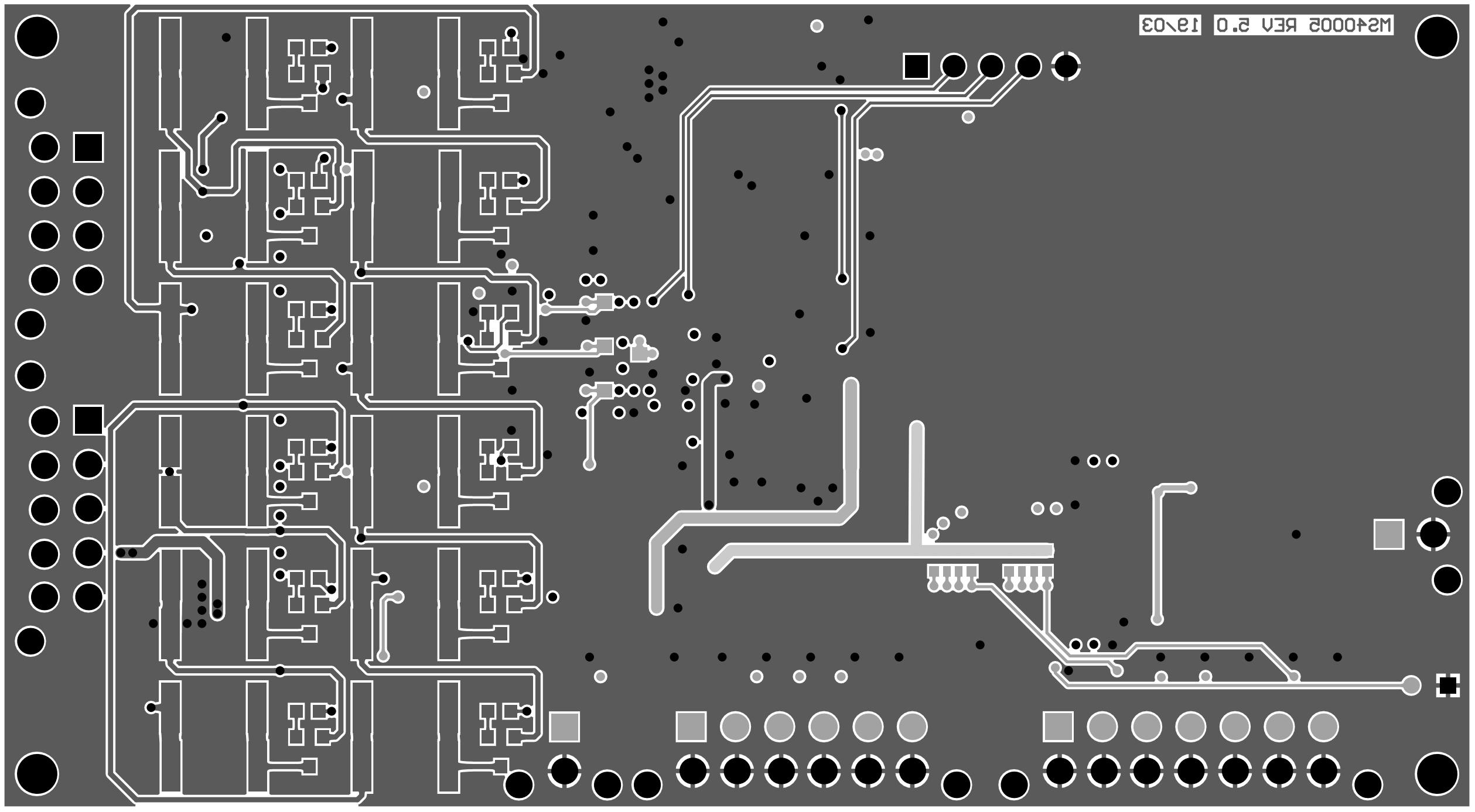
LibRef	Designator	Manufacturer 1	Manufacturer Part Number 1	Supplier 1	Supplier Part Number 1	Supplier Unit Price 1	Quantity	Supplier Subtotal 1
CAP CER 0.1UF 100V 10% X7R 0805	C1	Murata	GCM21BR72A104KA37L	Digi-Key	490-4789-1-ND	0.5468	1	\$ 0.55
CAP CER 1UF 50V 10% X7R 0603	C2, C3, C4, C37, C42	Taiyo Yuden	UMK107AB7105KA-T	Digi-Key	587-3247-1-ND	0.37342	5	\$ 1.87
CAP CER 10nF 50V 5% X7R 0603	7, C18, C19, C20, C21, C22, C23, C24, C25, C	KEMET	C0603C103J5JACTU	Digi-Key	399-13384-1-ND	0.32541	33	\$ 10.74
CAP CER 0.1UF 50V 10% X7R 0603	C38, C39, C45	Kyocera AVX	06035C-104KAT2A	Digi-Key	478-5052-1-ND	0.21338	3	\$ 0.64
CAP CER 10uF 25V 10% X5R 0805	C41	Murata	GRM21BR61E106KA73L	Digi-Key	490-5523-1-ND	0.57347	1	\$ 0.57
CAP CER 2.2uF 25V 10% X5R 0603	C43	Murata	GRM188R61E225KA12D	Digi-Key	490-10731-1-ND	0.22672	1	\$ 0.23
CAP CER 2.2uF 100V ±20% X7R 1206	C44, C46	Murata	GRM31CR72A225MA73L	Digi-Key	490-12773-1-ND		2	
DIODE ZENER 6.8V 500MW SOD123	, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D	Diodes	MMSZ5235B-7-F	Digi-Key	MMSZ5235B-FDICT-ND	0.27206	12	\$ 3.26
FUSE 375mA 125VDC 1206	F3, F4, F5, F6, F7, F8, F9, F10, F11, F12, F13,	Littelfuse	0466.375NR	Digi-Key	F1453CT-ND	1.05	15	\$ 15.74
IND 220uH 0.59A 20%	L1	Laird Steward	TYS6045221M-10	Digi-Key	240-2742-1-ND	0.76018	1	\$ 0.76
LED RED CLEAR 2V 0603	LED1	Wurth Electronics	150060RS75000	Digi-Key	732-4978-1-ND	0.18671	1	\$ 0.19
LED GREEN CLEAR 2V 0603	LED2	Wurth Electronics	150060VS75000	Digi-Key	732-4980-1-ND	0.18671	1	\$ 0.19
CONN 8POS MICRO-FIT 3mm	P1	Molex	43045-0827	Digi-Key	WM10684-ND	2.56	1	\$ 2.56
CONN 2POS DURA-CLIK 0.079" VERT	P2, P3	Molex	560020-0220	Digi-Key	WM10862CT-ND	1.04	2	\$ 2.08
CONN 10POS MICRO-FIT 3mm	P4	Molex	43045-1027	Digi-Key	WM7488-ND	3	1	\$ 3.00
CONN 12POS MICRO-FIT 3mm	P6	Molex	43045-1227	Digi-Key	WM10697-ND	3.44	1	\$ 3.44
CONN 2POS MICRO-FIT 3mm	P7, P8	Molex	43045-0227	Digi-Key	WM10657-ND	1.12	2	\$ 2.24
CONN 14POS MICRO-FIT 3mm	P9	Molex	43045-1427	Digi-Key	WM10707-ND	4.35	1	\$ 4.35
MOSFET P-CH 30V 3.8A SOT-23	, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q	Diodes	DMP3099L-7	Digi-Key	DMP3099L-7DICT-ND	0.4081	12	\$ 4.90
RES 100 OHM 1% 1/10W 0603	R54, R55, R56, R57, R58, R59, R60, R61, R62	Yageo	RC0603FR-07100RL	Digi-Key	311-100HRCT-ND	0.03201	15	\$ 0.48
RES 0.0 OHM 1/4W 0603	R3	Vishay Dale	CRCW06030000Z0EAHP	Digi-Key	541-0.0SBCT-ND	0.22672	1	\$ 0.23
RES 4.7K OHM 1% 1/10W 0603	R4, R5, R6, R7, R14	Yageo Phycomp	RC0603FR-074K7L	Digi-Key	311-4.70KHRCT-ND	0.13336	5	\$ 0.67
RES 1.4k OHM 1% 1/10W 0603	R8	Yageo	RC0603FR-071K4L	Digi-Key	311-1.40KHRCT-ND	0.13336	1	\$ 0.13
RES 604 OHM 1% 1/10W 0603	R12	Yageo	RC0603FR-07604RL	Digi-Key	311-604HRCT-ND	0.13336	1	\$ 0.13
RES 100K OHM 5% 1/8W 0603	R13	Yageo	RC0603JR-07100KL	Digi-Key	311-100KGRCR-ND	0.13336	1	\$ 0.13
RES 3.3K OHM 1% 1/4W 0603	6, R21, R22, R27, R28, R33, R34, R39, R40, R	Panasonic	ERJPA3F3301V	Digi-Key	P3.3KBYCT-ND	0.19205	12	\$ 2.30
RES 33 OHM 5% 1.5W 2512	6, R29, R30, R31, R32, R35, R36, R37, R38, R	Stackpole Electronics	RPC2512JT33R0	Digi-Key	RPC2512JT33R0CT-ND	0.53879	24	\$ 12.93
RES 62 OHM 0.1% 1/10W 0603	R66, R67, R68, R69	Panasonic	ERA3AE8620V	Digi-Key	P62DBCT-ND	0.46678	4	\$ 1.87
RES ARRAY 10K OHM 0.1% 4RES 1206	R70, R71, R72, R73	Vishay Beyschlag	ACASA1002S1002P100	Digi-Key	749-1023-1-ND	1.07	4	\$ 4.27
RES 820 OHM 5% 1/4W 0603	R75	Rohm	ESR03EZPJ821	Digi-Key	RHM820DCT-ND	0.13336	1	\$ 0.13
RES 10K OHM 1% 1/10W 0603	R76	Yageo Phycomp	RC0603FR-0710KL	Digi-Key	311-10.0KHRCT-ND	0.13336	1	\$ 0.13
RES 255K OHM 1% 1/10W 0603	R77	Yageo	RC0603FR-07255KL	Digi-Key	311-255KHRCT-ND	0.13336	1	\$ 0.13
RES 191K OHM 1% 1/10W 0603	R78	Yageo	RC0603FR-07191KL	Digi-Key	311-191KHRCT-ND	0.13336	1	\$ 0.13
RES 39.2K OHM 1% 1/10W 0603	R79	Yageo	RC0603FR-0739K2L	Digi-Key	311-39.2KHRCT-ND	0.13336	1	\$ 0.13
NTC THERMISTOR 10K 1% BEAD	RT1	Murata	NXRT15KH103FA1B030	Digi-Key	490-8601-ND	0.93355	1	\$ 0.93
IC MONITOR BATT STACK 48SSOP	U1	Analog Devices / Linear Technology	LTC6804IG-1#PBF	Digi-Key	LTC6804IG-1#PBF-ND	28.3	1	\$ 28.30
IC MUX/DEMUX 1X16 24SSOP	U2	Texas Instruments	CD74HC4067M96	Digi-Key	296-29408-1-ND	1.07	1	\$ 1.07
IC OP AMP GEN PURPOSE RR 10MHZ SOT-23-5	U3	Texas Instruments	TLV316QDBVRQ1	Digi-Key	296-45323-1-ND	1.13	1	\$ 1.13
IC REG BUCK ADJ 0.1A 10UMAX	U4	Maxim	MAX17552AUB+	Digi-Key	MAX17552AUB+-ND	3.73	1	\$ 3.73
IC REG LDO 5V 0.1A SOT23-5	U5	STMicroelectronics	LD2981CM50TR	Digi-Key	497-7787-1-ND	0.86687	1	\$ 0.87
COP AMP GEN PURPOSE RR 5.5MHZ SOT-23-5	U6	Texas Instruments	OPA376AQDBVRQ1	Digi-Key	296-36701-1-ND	2.85	1	\$ 2.85
IC PULSE XFMR 1CT:1CT 350uH SMD	XFMR1	Bourns	PT61018AAPEL-S	Digi-Key	PT61018AAPEL-SCT-ND	5.11	1	\$ 5.11
					Total:			\$ 125.10





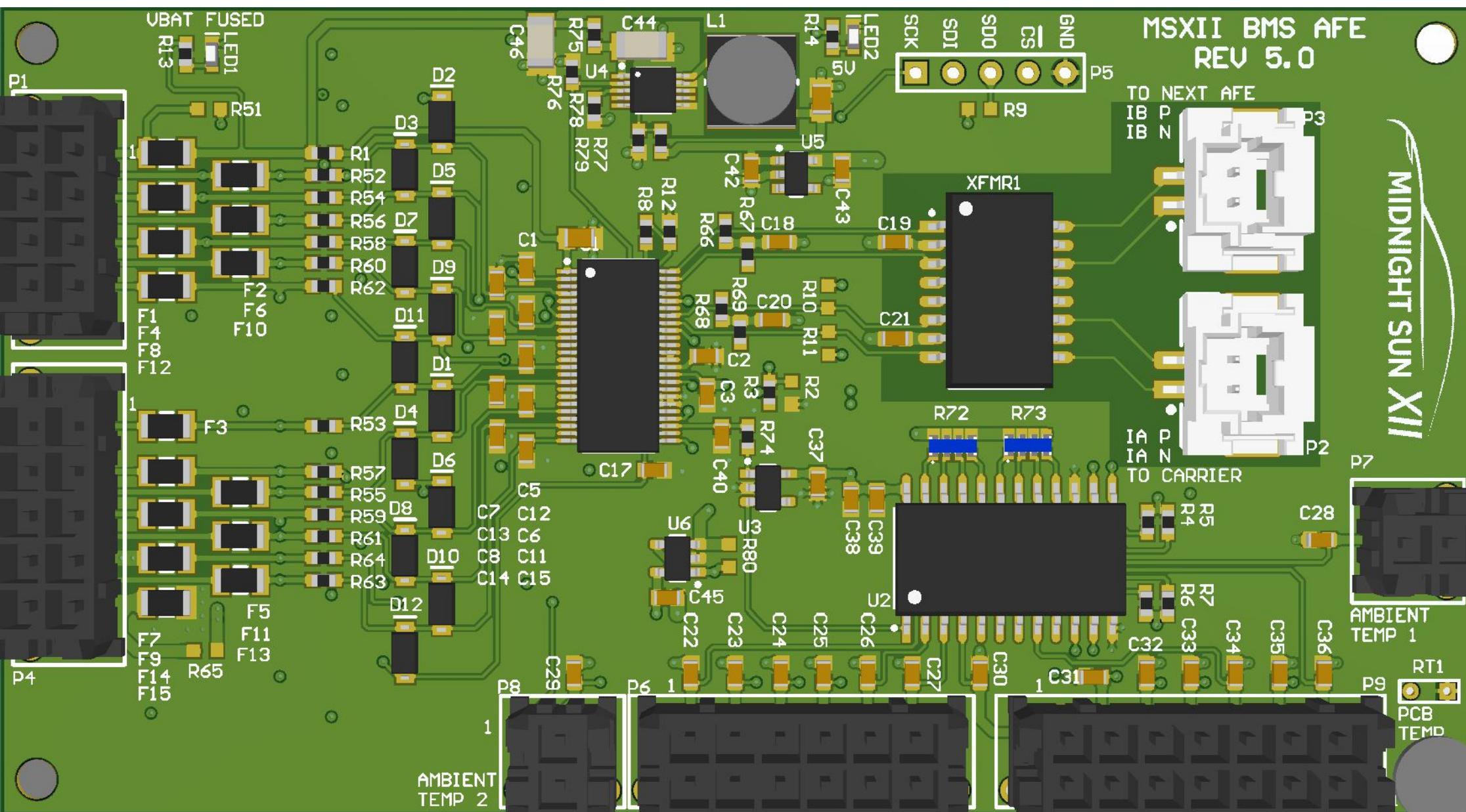


MS40005 REV 5.0 1a\03



MSXII BMS AFE
REV 5.0

MIDNIGHT SUN XII



Electrical Rules Check Report

Class	Document	Message
Warning	BMS AFE - AFE.SchDoc	3V0_VREF2 contains Input Pin and Unspecified Port objects (Pin U6-4,Port 3V0_VREF2)
Warning	BMS AFE - AFE.SchDoc	3V0_VREF2 contains Output Pin and Unspecified Port objects (Port 3V0_VREF2)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_0 at (660,40)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_1 at (660,50)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_2 at (660,60)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_3 at (660,70)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_4 at (660,80)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_5 at (660,90)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_6 at (660,100)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_7 at (660,110)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_8 at (660,120)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_9 at (660,130)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_10 at (660,140)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_11 at (660,150)
Warning	BMS AFE - Cell Inputs.SchDoc	Floating Net Label FUSED_CELL_12 at (660,160)
Warning	BMS AFE - Top Sheet.SchDoc	FUSED_VBAT+ contains Input Sheet Entry and Unspecified Sheet Entry objects (Sheet Entry BMS AFE - Cell Inputs-FUSED_VBAT+(Passive),Sheet Entry U_BMS AFE - Regulator-VIN(Input))
Warning	BMS AFE - Regulator.SchDoc	FUSED_VBAT- contains Input Pin and Unspecified Port objects (Pin U2-6,Port FUSED_VBAT-)
Warning	BMS AFE - Thermistors.SchDoc	FUSED_VBAT- contains Input Pin and Unspecified Port objects (Pin U2-15,Port FUSED_VBAT-)
Warning	BMS AFE - Regulator.SchDoc	FUSED_VBAT- contains Input Pin and Unspecified Port objects (Pin U4-6,Port FUSED_VBAT-)
Warning	BMS AFE - Thermistors.SchDoc	FUSED_VBAT- contains Input Pin and Unspecified Port objects (Pin U5-15,Port FUSED_VBAT-)
No Report	BMS AFE - Communications.SchDoc	Net IB_N has no driving source (Pin R67-2,Pin U1-47,Pin XFMR1-3)
No Report	BMS AFE - Communications.SchDoc	Net IB_P has no driving source (Pin R66-1,Pin U1-48,Pin XFMR1-1)
No Report	BMS AFE - Top Sheet.SchDoc	Net NetP4_10 has only one pin (Pin P4-10)
No Report	BMS AFE - AFE.SchDoc	Net NetR2_2 has no driving source (Pin R2-2,Pin R3-1,Pin U1-40)
No Report	BMS AFE - AFE.SchDoc	Net NetR8_1 has no driving source (Pin R8-1,Pin U1-45)
No Report	BMS AFE - AFE.SchDoc	Net NetR8_2 has no driving source (Pin R8-2,Pin R12-1,Pin U1-46)
Warning	BMS AFE - Top Sheet.SchDoc	Nets Wire FUSED_VBAT+ has multiple names (Power Object FUSED_VBAT+,Power Object FUSED_VBAT+,Power Object FUSED_VBAT+,Power Object FUSED_VBAT+,Power Object FUSED_VBAT+,Power Object FUSED_VBAT+,Power Object FUSED_VBAT+,Sheet Entry BMS AFE - AFE-FUSED_VBAT+(Passive),Sheet Entry BMS AFE - Cell Inputs-FUSED_VBAT+(Passive),Sheet Entry U_BMS AFE - Regulator-VIN(Input))
Warning	BMS AFE - Top Sheet.SchDoc	Nets Wire FUSED_VBAT- has multiple names (Sheet Entry BMS AFE - AFE-FUSED_VBAT+(Passive),Sheet Entry BMS AFE - Cell Inputs-FUSED_VBAT+(Passive),Sheet Entry U_BMS AFE - Regulator-VIN(Input),Power Object FUSED_VBAT-,Power Object FUSED_VBAT-,Power Object FUSED_VBAT-) NetU1_27 contains IO Pin and Input Port objects (Port AFE_TEMPERATURE_SENSE)
Warning	BMS AFE - AFE.SchDoc	

Design Rules Verification Report

Filename : C:\Users\Taiping\Documents\Midnight Sun\hardware\MSXII_BMS_AFE\AFE.PcbDc

Warnings 0

Rule Violations 5

Warnings	
Total	0

Rule Violations	
Clearance Constraint (Gap=0.152mm) (All), (All)	0
Clearance Constraint (Gap=0.6mm) (Disabled)(InNetClass('HV_IN')), (InNet('+6V'))	0
Clearance Constraint (Gap=0.6mm) (Disabled)(InNetClass('HV_IN')), (InNet('+5V'))	0
Clearance Constraint (Gap=0.6mm) (Disabled)(InNetClass('HV_IN')), (InNet('GND'))	0
Short-Circuit Constraint (Allowed=No) (All), (All)	0
Un-Routed Net Constraint (All)	0
Modified Polygon (Allow modified: No), (Allow shelved: No)	0
Width Constraint (Min=0.2mm) (Max=2.54mm) (Preferred=0.35mm) (All)	0
Power Plane Connect Rule(Relief Connect)(Expansion=0.508mm) (Conductor Width=0.254mm) (Air Gap=0.152mm)	0
Hole Size Constraint (Min=0.025mm) (Max=100mm) (All)	0
Hole To Hole Clearance (Gap=0.254mm) (All), (All)	0
Net Antennae (Tolerance=0mm) (All)	0
Board Clearance Constraint (Gap=0mm) (All)	5
Height Constraint (Min=0mm) (Max=25.4mm) (Preferred=12.7mm) (All)	0
Total	5

Board Clearance Constraint (Gap=0mm) (All)
Board Outline Clearance(Outline Edge): (Collision < 0.295mm) Between Board Edge And Text "1" (99.65mm,18.85mm) on Top Overlay
Board Outline Clearance(Outline Edge): (Collision < 0.295mm) Between Board Edge And Text "10" (0.9mm,13.8mm) on Top Overlay
Board Outline Clearance(Outline Edge): (Collision < 0.295mm) Between Board Edge And Text "8" (0.5mm,36.4mm) on Top Overlay
Board Outline Clearance(Outline Edge): (Collision < 0.295mm) Between Board Edge And Text "MSXII BMS AFE

REV 5.0" (77mm,50mm) on Top Overlay

Board Clearance Constraint (Gap=0mm) (All)
Board Outline Clearance(Outline Edge): (Collision < 0.295mm) Between Board Edge And Text "PCB

TEMP" (94.847mm,5.1mm) on Top Overlay