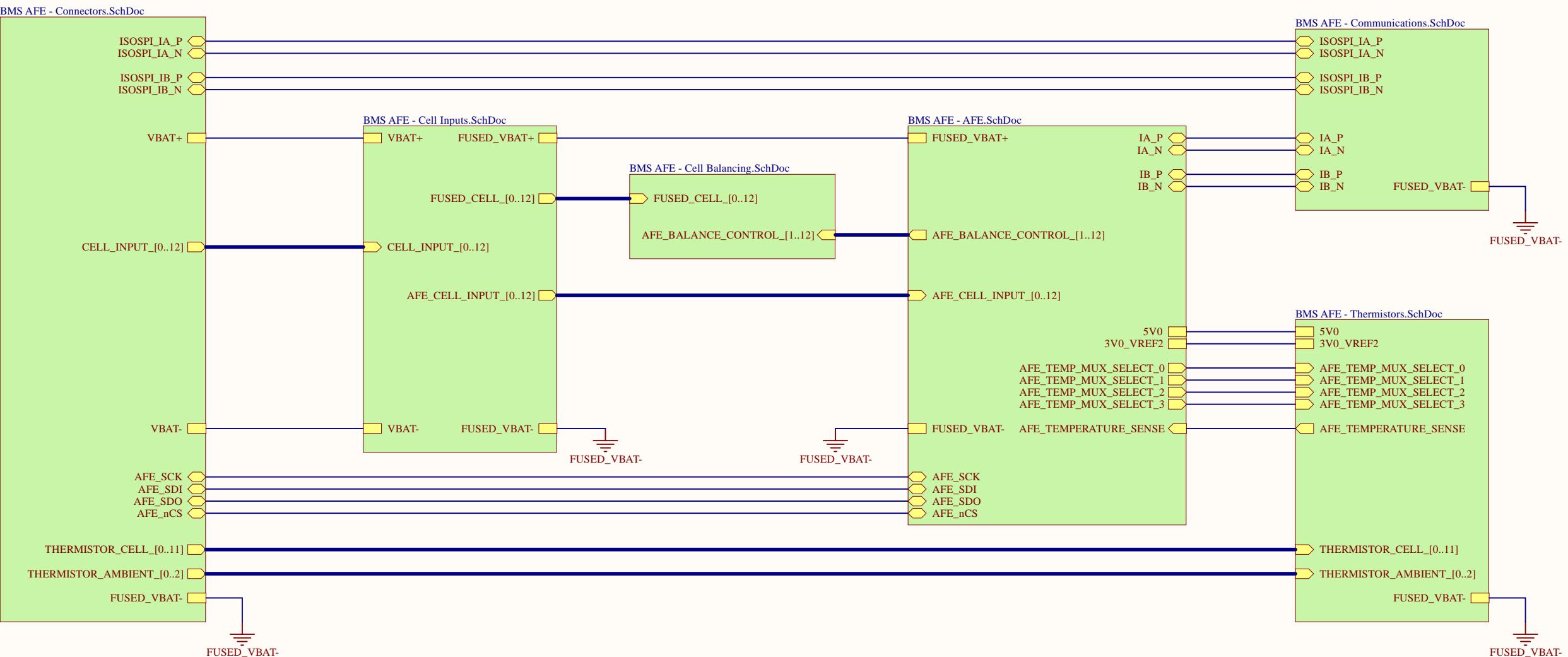


A

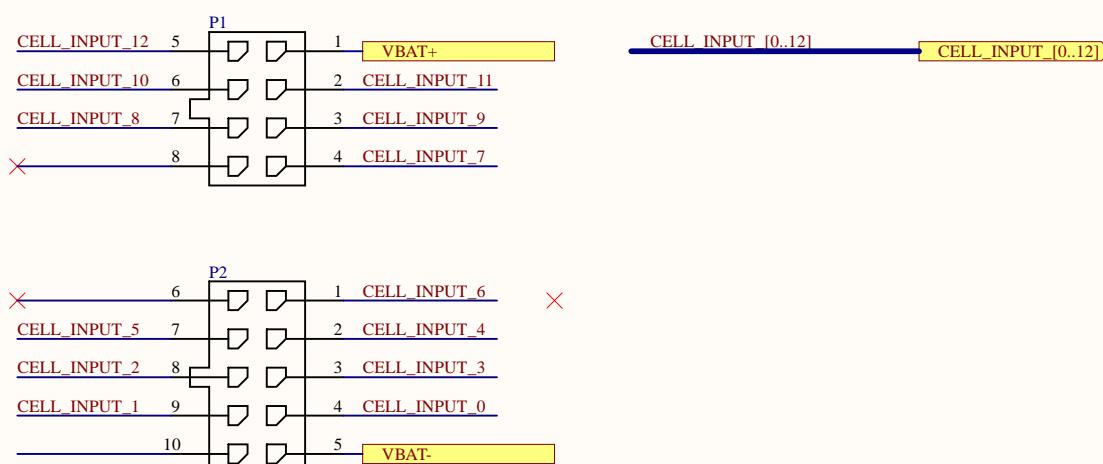


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Top Sheet.SchDoc	
PART NUMBER	MS40005	VARIANT [No Variations]
DRAWN BY	Taiping Li	REVISION 4.1
LAST MODIFIED	2018-12-22	SHEET 1 OF 7

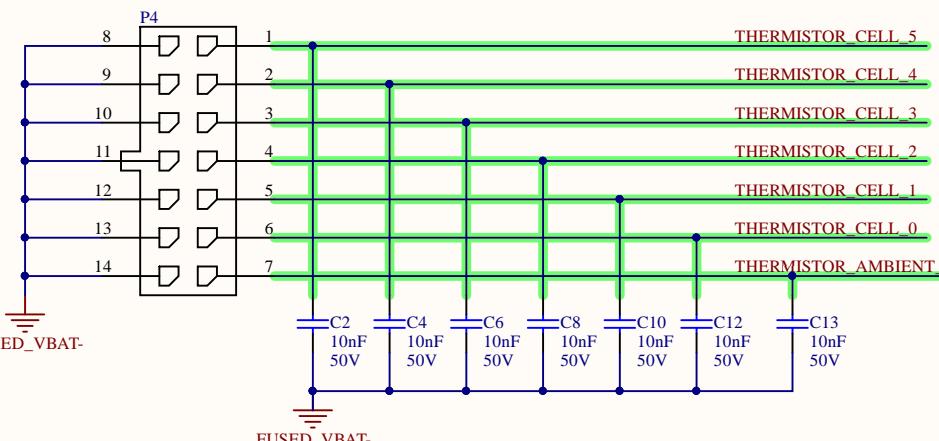
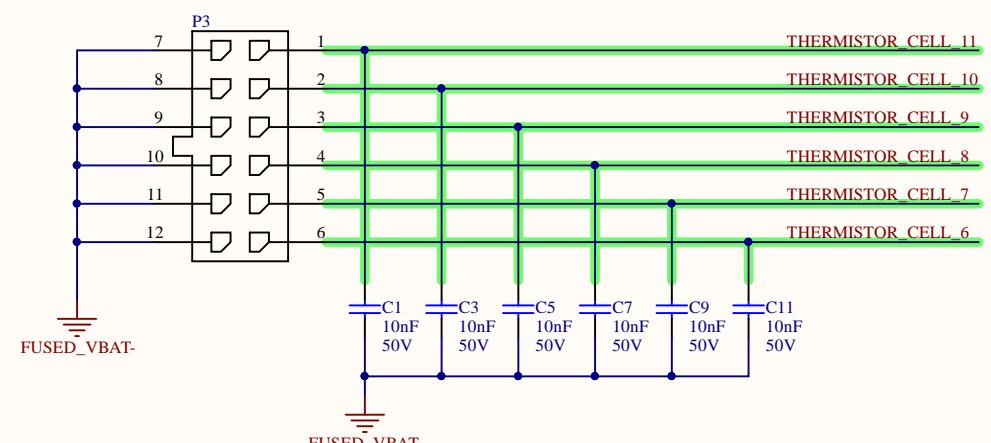


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hardware@uwmidsun.com

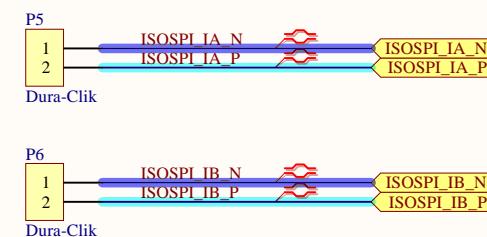
## Cell Inputs



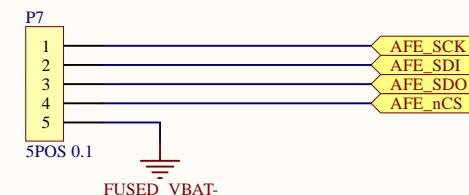
## Cell Thermistors



## isoSPI Connectors

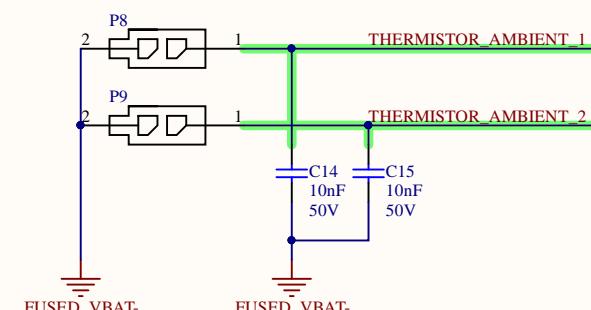


## Optional 4-wire SPI

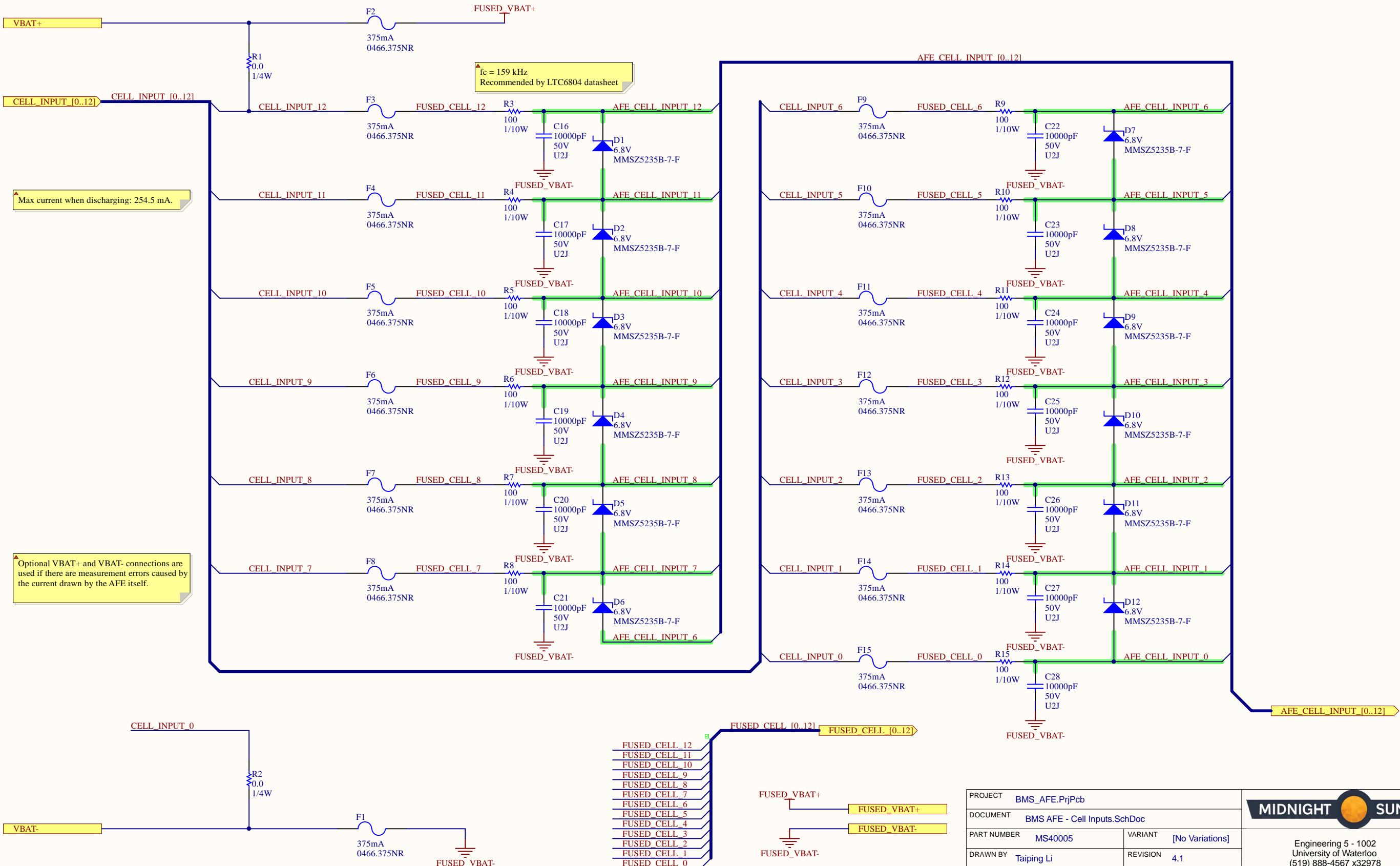


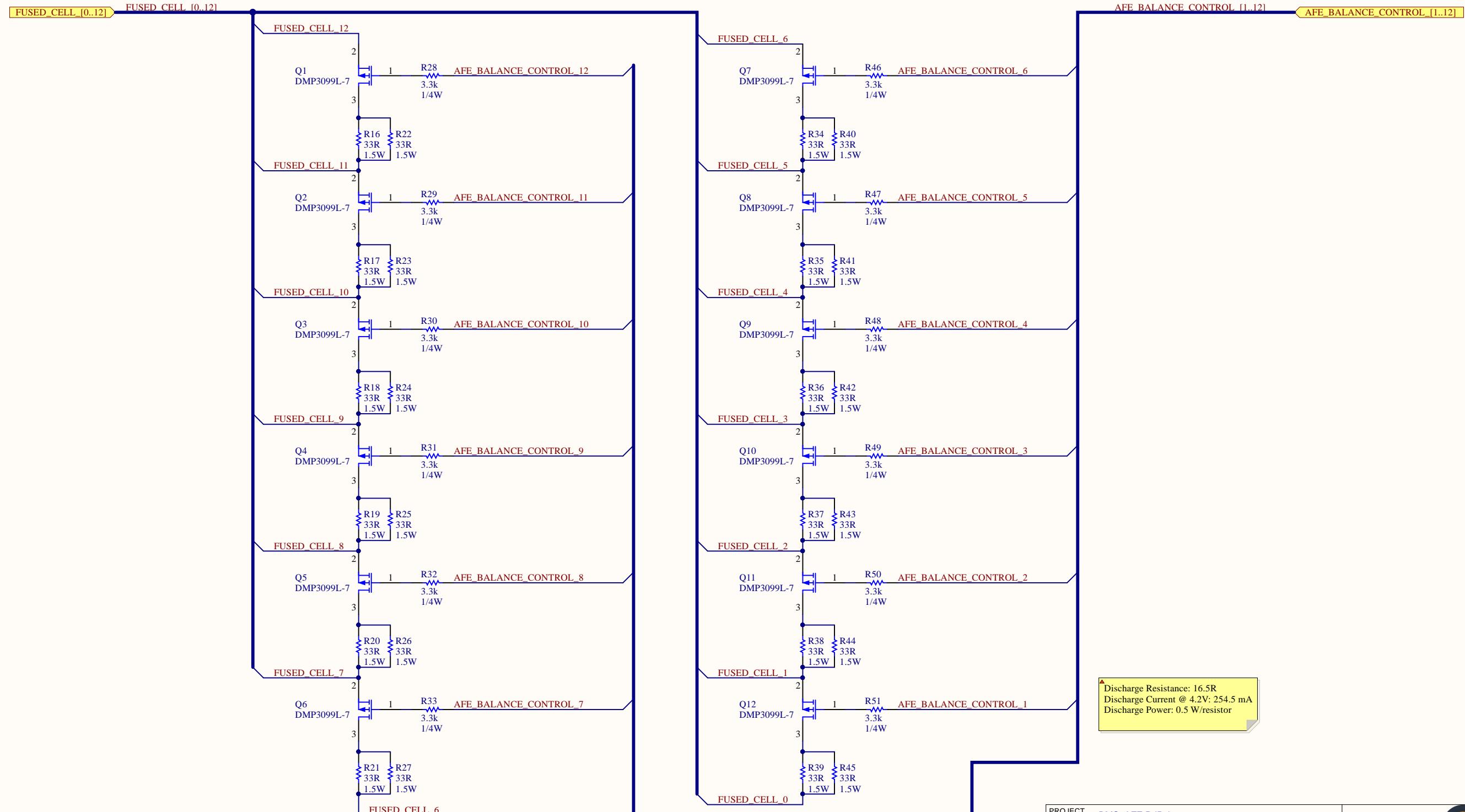
▲ Use variant Debug - SPI and solder on a 0.1" header to talk to the LTC6804 via SPI.  
Otherwise, communication should be isoSPI.

## Ambient Thermistors

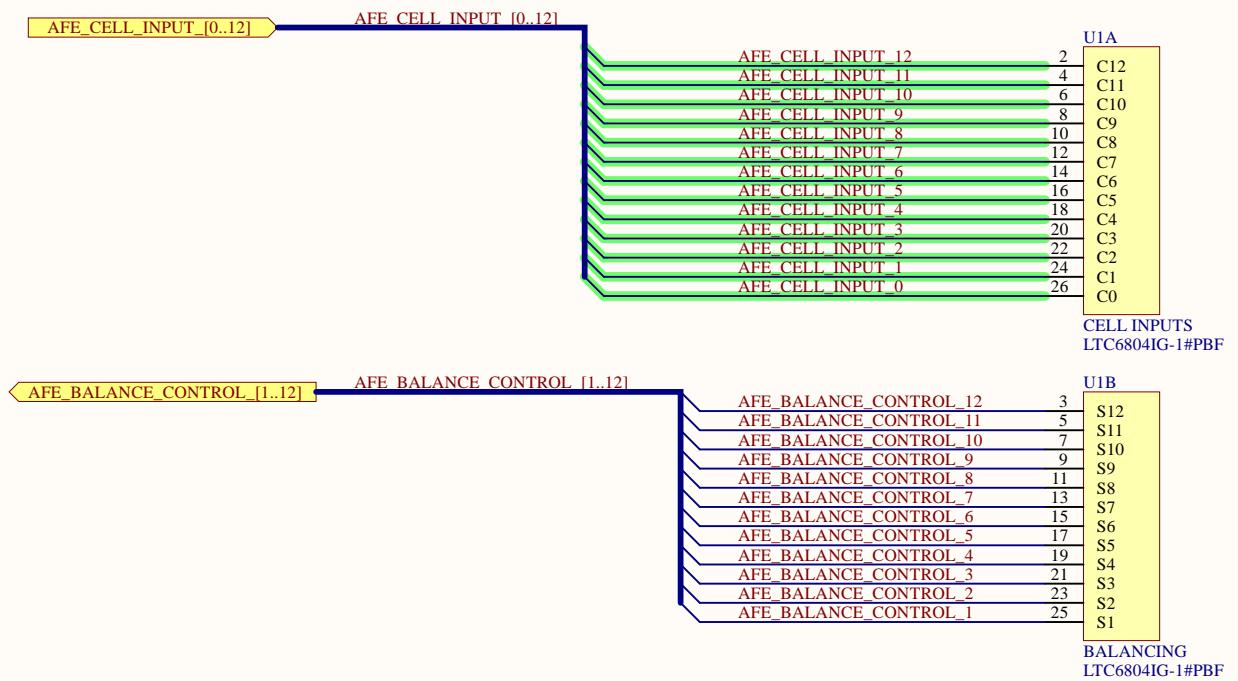
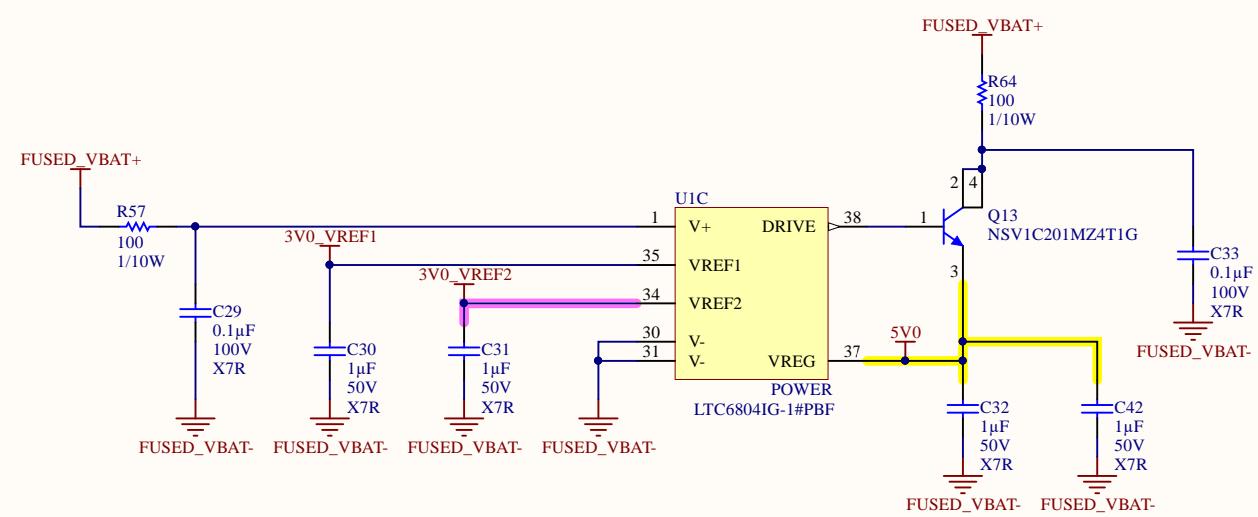
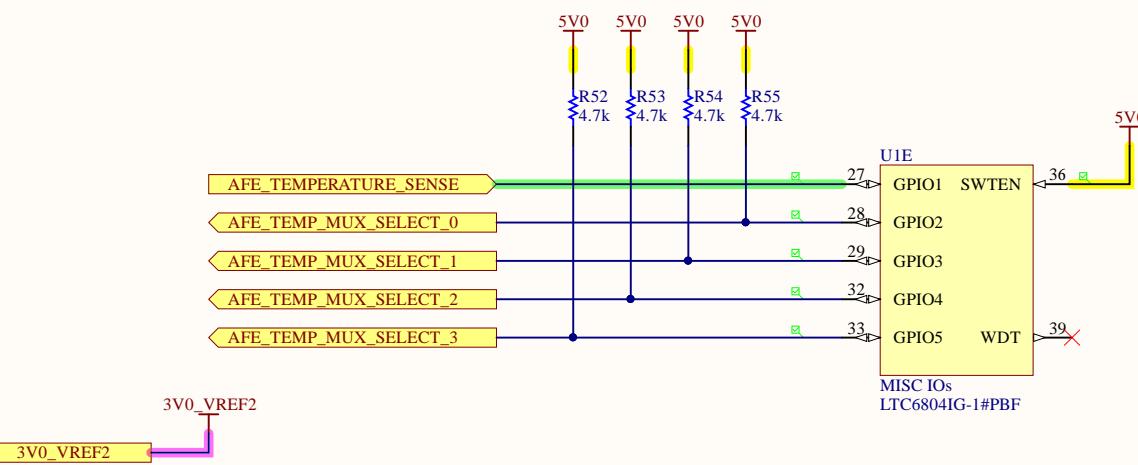
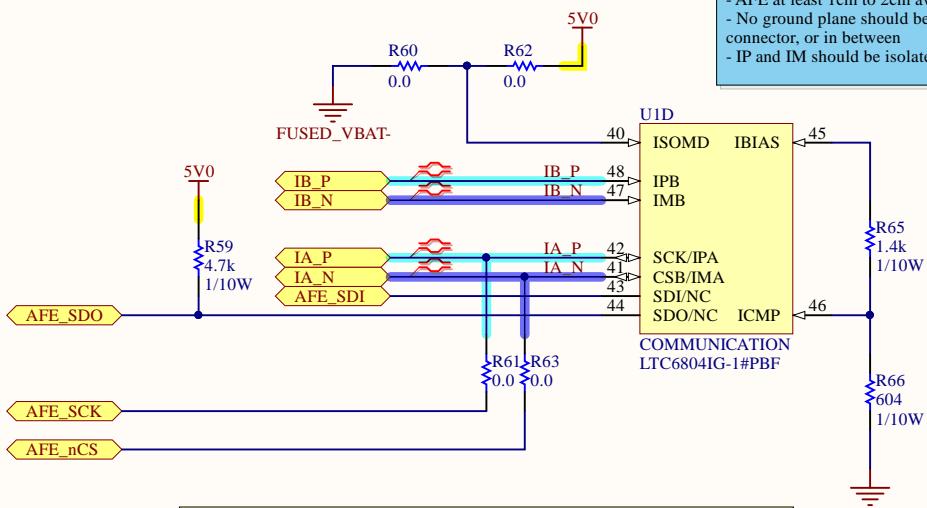
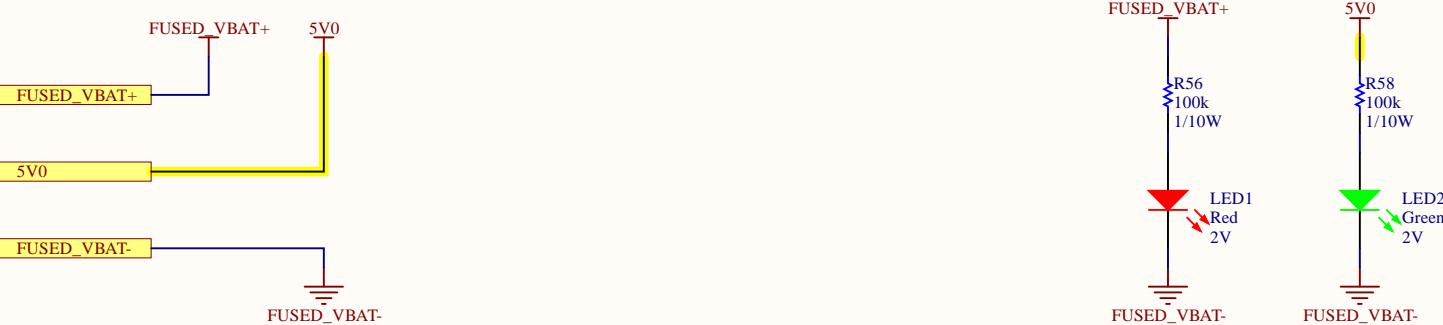


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Connectors.SchDoc	
PART NUMBER	MS40005	VARIANT [No Variations]
DRAWN BY	Taiping Li	REVISION 4.1
LAST MODIFIED	2018-12-22	SHEET 2 OF 7





PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Cell Balancing.SchDoc	
PART NUMBER	MS40005	VARIANT [No Variations]
DRAWN BY	Taiping Li	REVISION 4.1
LAST MODIFIED	2018-12-22	SHEET 4 OF 7

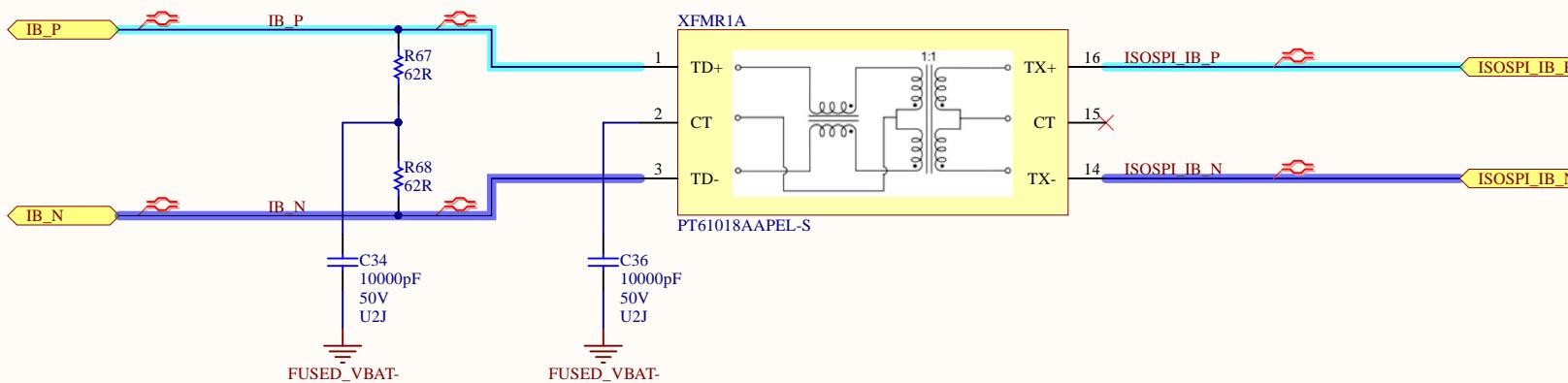
**Cell & Balancing Inputs****Power****GPIOs****Communication****LEDs**

PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - AFE.SchDoc	
PART NUMBER	MS40005	VARIANT [No Variations]
DRAWN BY	Taiping Li	REVISION 4.1
LAST MODIFIED	2018-12-22	SHEET 5 OF 7

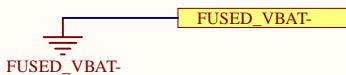
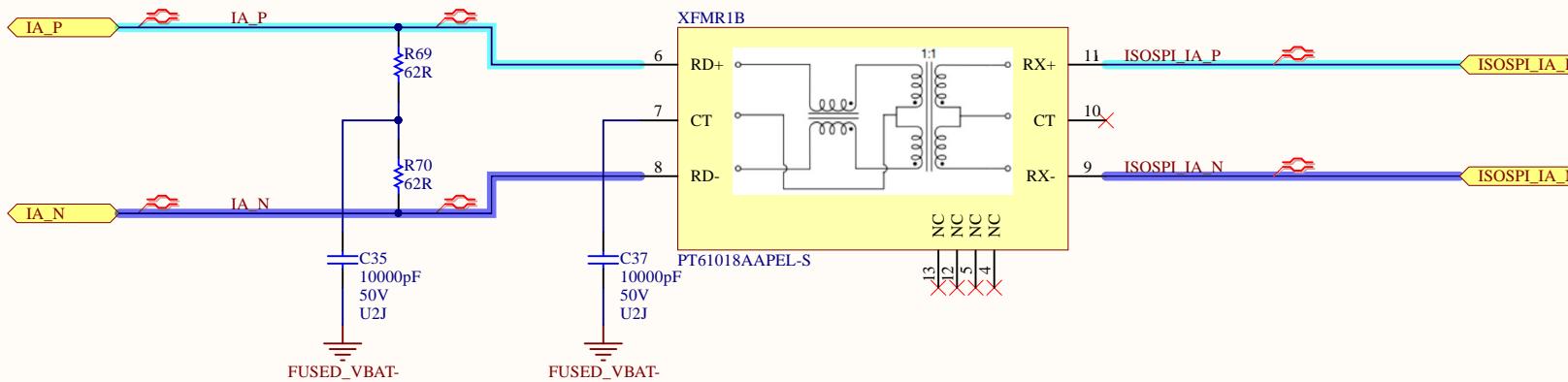
**MIDNIGHT SUN**

## isoSPI

## MASTER - TO NEXT AFE



## SLAVE - FROM LTC6820

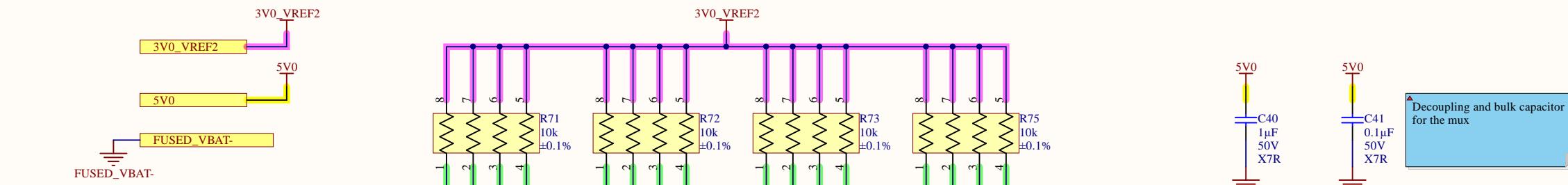


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Communications.SchDoc	
PART NUMBER	MS40005	VARIANT [No Variations]
DRAWN BY	Taiping Li	REVISION 4.1
LAST MODIFIED	2018-12-22	SHEET 6 OF 7

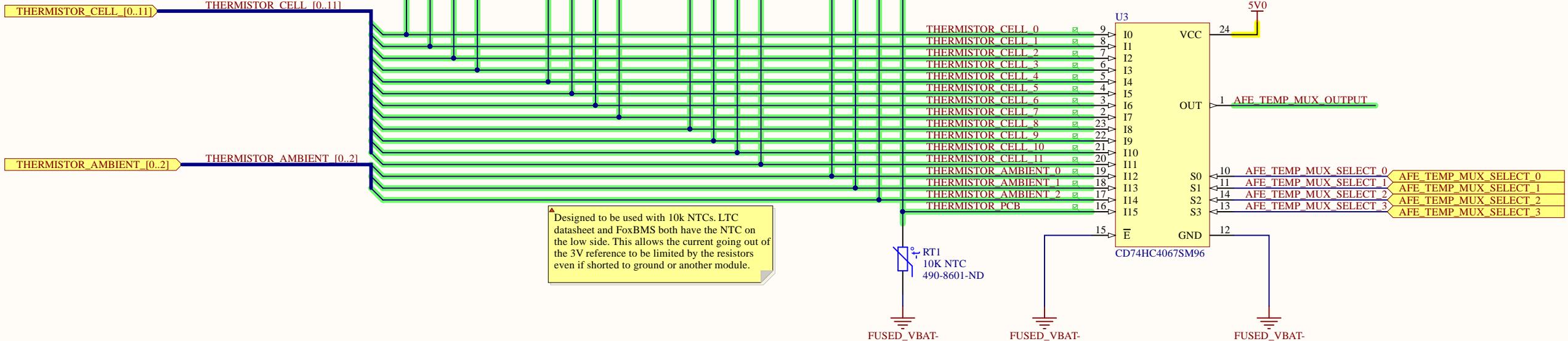


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 hardware@uwmidsun.com

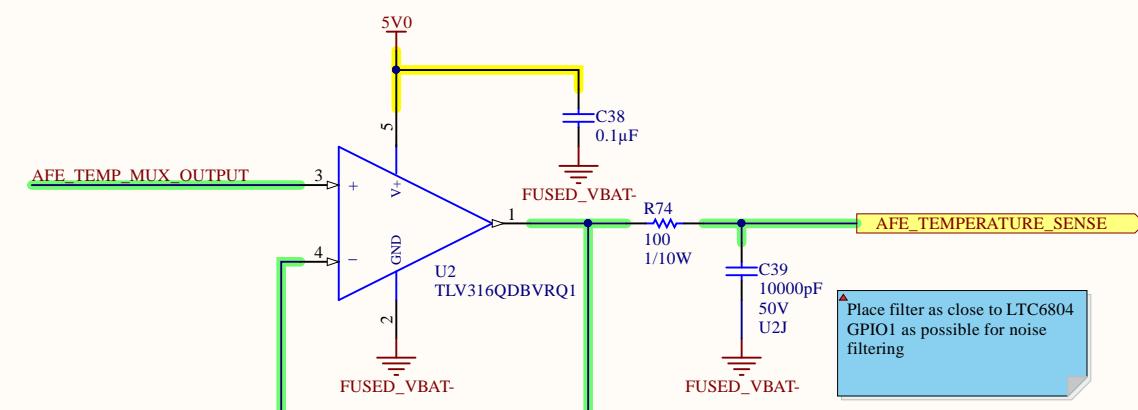
A



B



C



PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Thermistors.SchDoc	
PART NUMBER	MS40005	VARIANT [No Variations]
DRAWN BY	Taiping Li	REVISION 4.1
LAST MODIFIED	2018-12-22	SHEET 7 OF 7

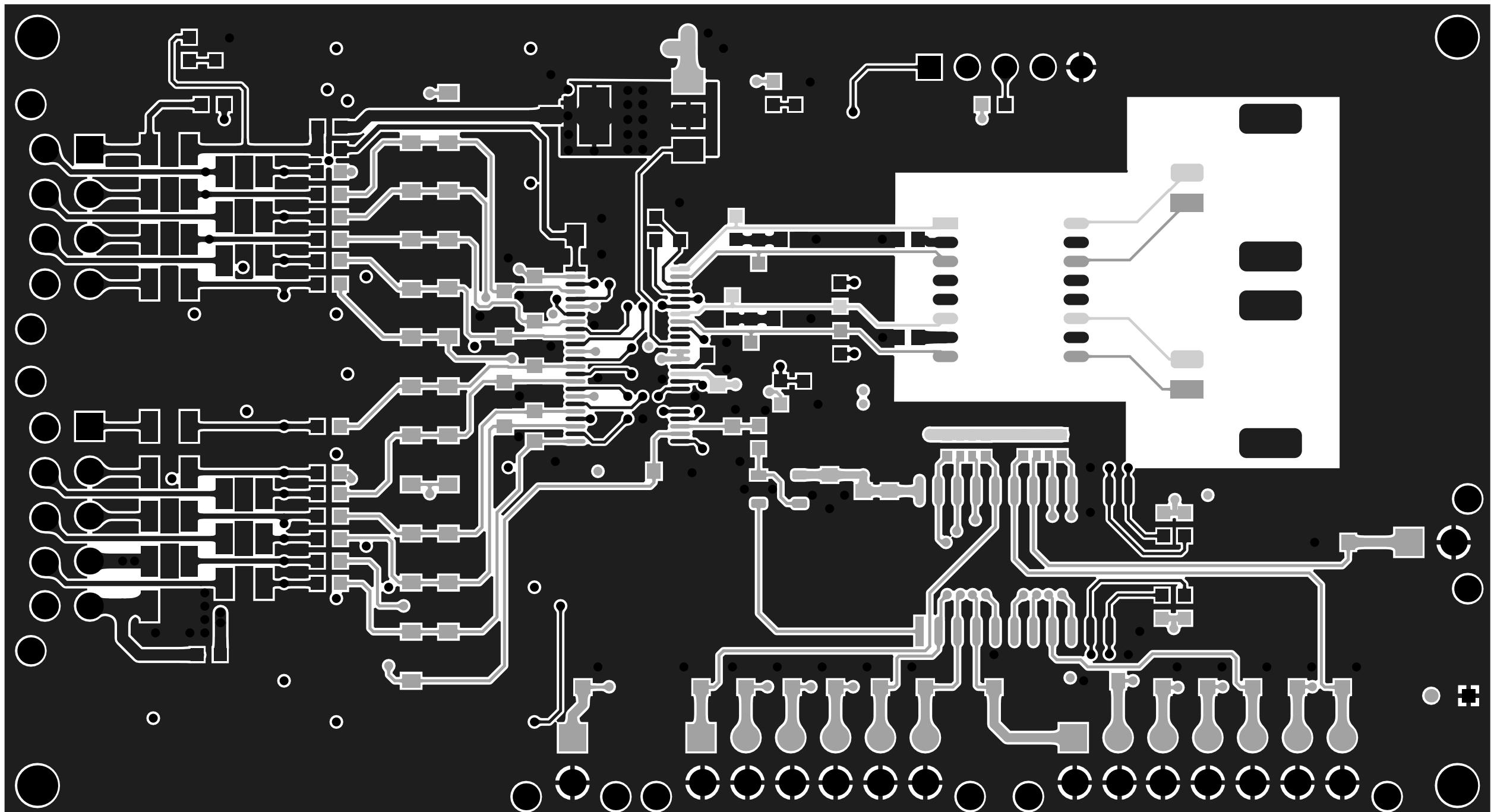
## Bill of Materials

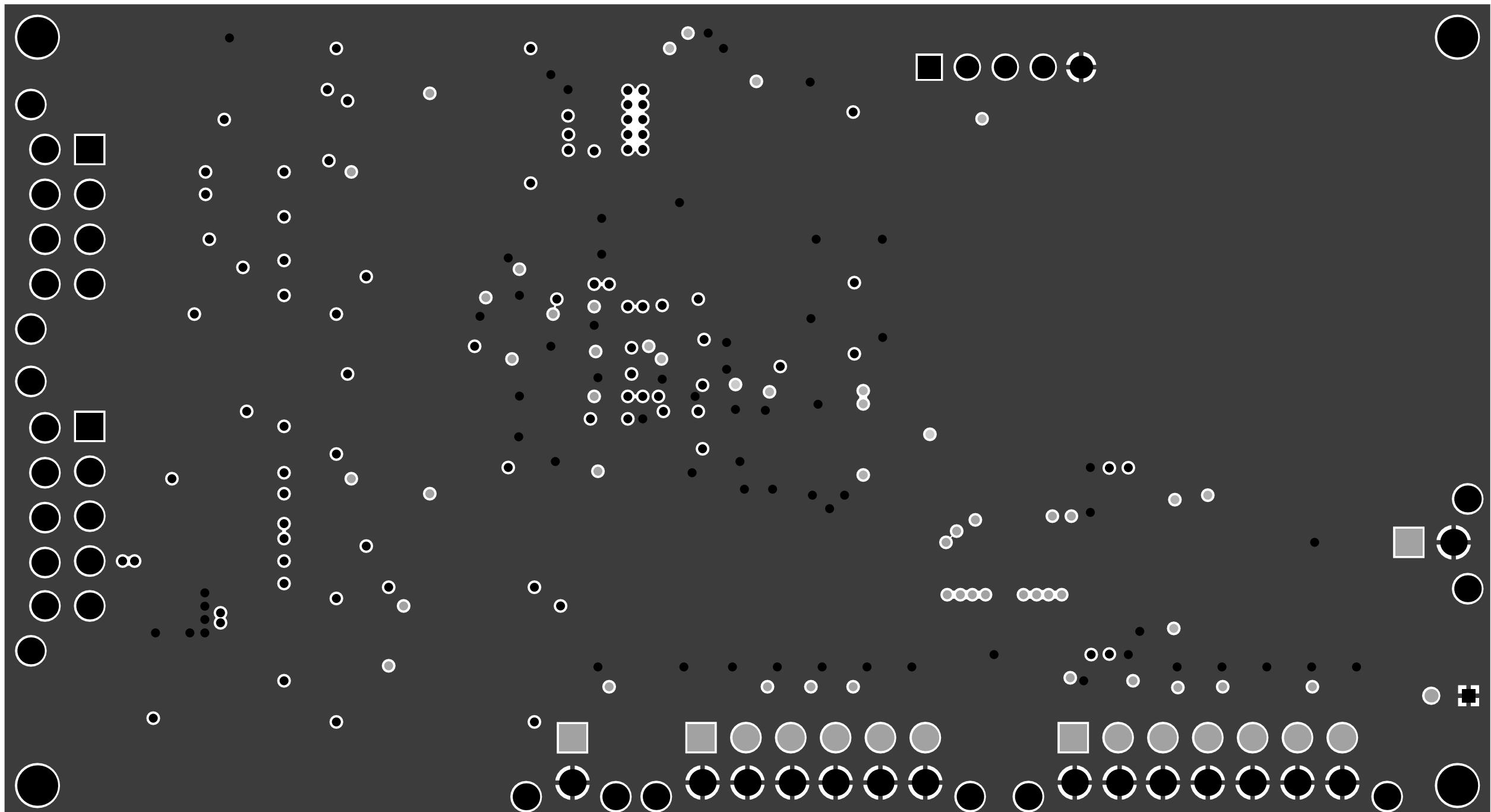
Project:	BMS_AFE.PjrPcb
Revision:	4.1
Project Lead:	Taiping Li
Generated On:	2018-12-22 9:46:23 PM
Production Quantity:	1
Currency	CAD
Total Parts Count:	165

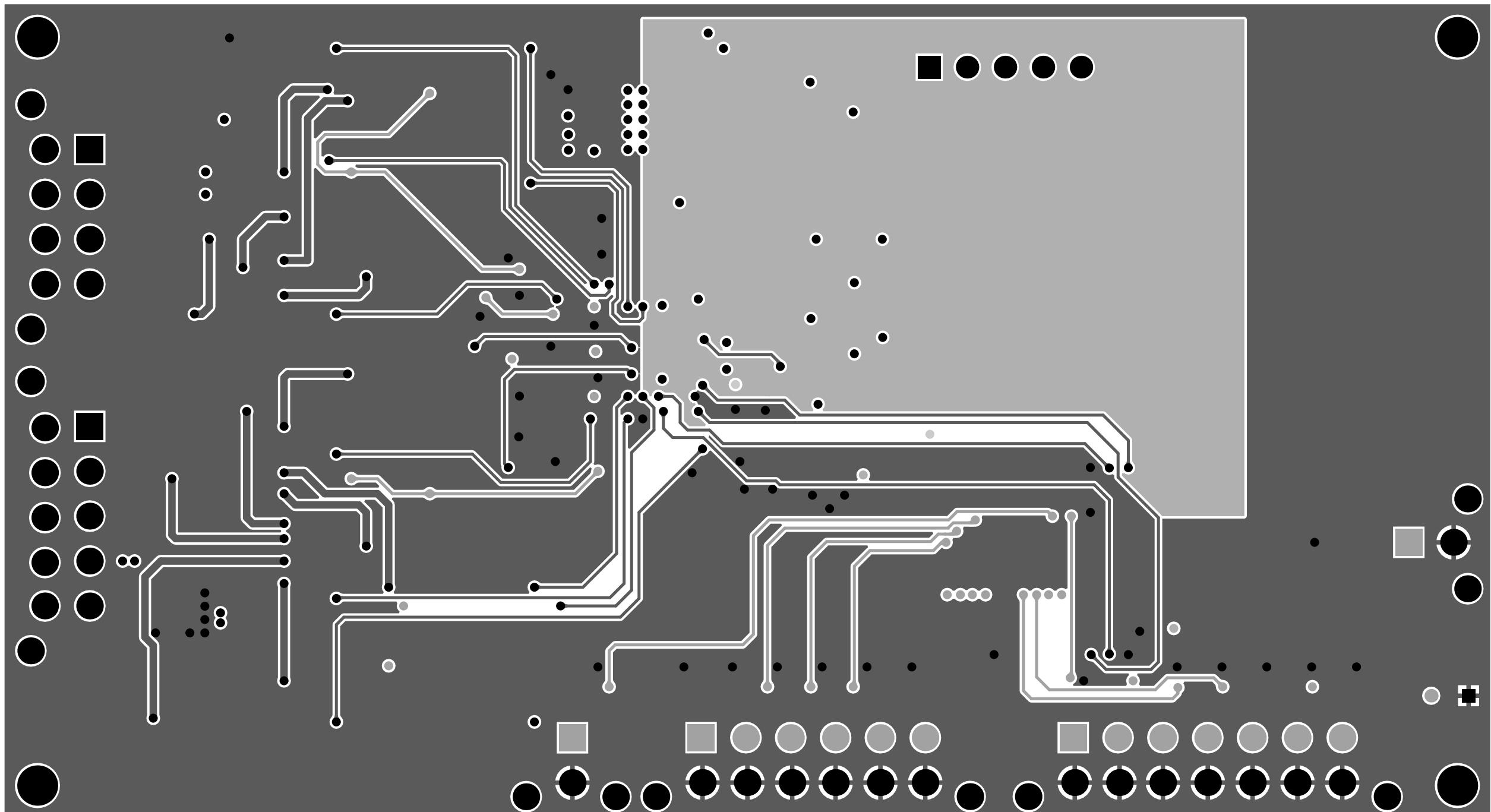
MIDNIGHT SUN



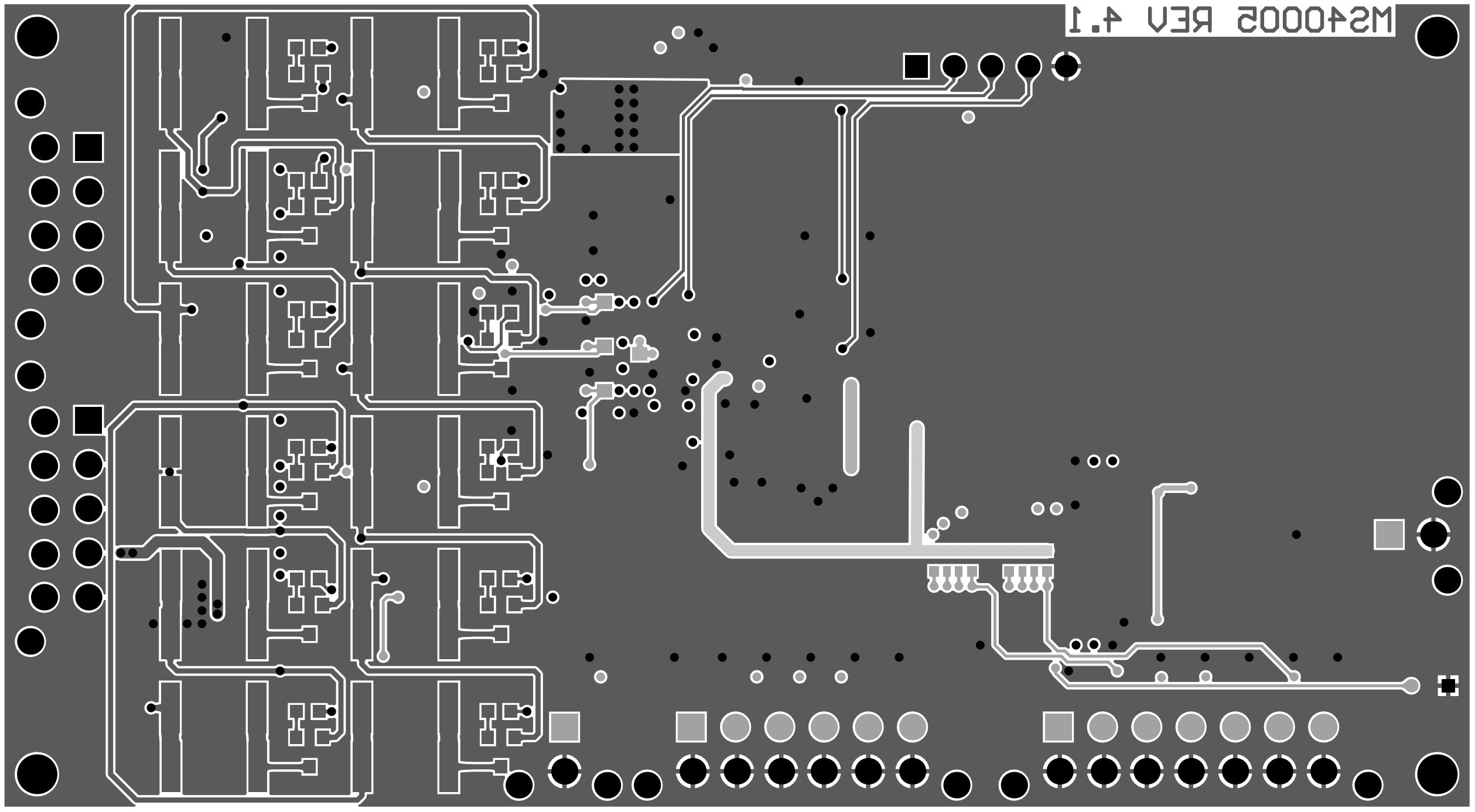
LibRef	Designator	Manufacturer 1	Manufacturer Part Number 1	Supplier 1	Supplier Part Number 1	Supplier Unit Price 1	Supplier Order Qty 1	Supplier Subtotal 1
CAP CER 0.1UF 100V 10% X7R 0805	C1, C2	Murata	GCM21BR72A104KA37L	Digi-Key	490-4789-1-ND	0.58	2	\$ 1.17
CAP CER 1UF 50V 10% X7R 0603	C3, C4, C5, C39	Taiyo Yuden	UMK107AB7105KA-T	Digi-Key	587-3247-1-ND	0.39	4	\$ 1.58
CAP CER 10nF 50V 5% X7R 0603	C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C42	KEMET	C0603C103J5JAC7867	Digi-Key	399-13384-1-ND	0.28	33	\$ 9.16
CAP CER 0.1UF 50V 10% X7R 0603	C40, C41	Kyocera AVX	06035C-104KAT2A	Digi-Key	478-5052-1-ND	0.23	2	\$ 0.46
DIODE ZENER 6.8V 500MW SOD123	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12	Diodes	MMSZ5235B-7-F	Digi-Key	MMSZ5235B-FDICT-ND	0.28	12	\$ 3.33
FUSE 375MA 125VDC 1206	F1, F2, F3, F4, F5, F6, F7, F8, F9, F10, F11, F12, F13, F14, F15	Littelfuse	0466.375NR	Digi-Key	F1453CT-ND	1.07	15	\$ 16.06
LED RED CLEAR 2V 0603	LED1	Wurth Electronics	150060RS75000	Digi-Key	732-4978-1-ND	0.19	1	\$ 0.19
LED GREEN CLEAR 2V 0603	LED2	Wurth Electronics	150060VS75000	Digi-Key	732-4980-1-ND	0.19	1	\$ 0.19
CONN 8POS MICRO-FIT 3mm	P1	Molex	43045-0827	Digi-Key	WM10684-ND	2.61	1	\$ 2.61
CONN 2POS DURA-CLIK 0.079" VERT	P2, P3	Molex	560020-0220	Digi-Key	WM10862CT-ND	1.06	2	\$ 2.12
CONN 10POS MICRO-FIT 3mm	P4	Molex	43045-1027	Digi-Key	WM7488-ND	3.06	1	\$ 3.06
CONN 12POS MICRO-FIT 3mm	P6	Molex	0430451227	Digi-Key	WM10697-ND			
CONN 2POS MICRO-FIT 3mm	P7, P8	Molex	0430450227	Digi-Key	WM10657-ND			
CONN 14POS MICRO-FIT 3mm	P9	Molex	43045-1427	Digi-Key	WM10707-ND	4.43	1	\$ 4.43
BJT NPN 100V 2A SOT223	Q1	ON Semiconductor	NSV1C201MZ4T1G	Digi-Key	NSV1C201MZ4T1GOSC-T-ND	0.94	1	\$ 0.94
MOSFET P-CH 30V 3.8A SOT-23	Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13	Diodes	DMP3099L-7	Digi-Key	DMP3099L-7DICT-ND	0.42	12	\$ 5.04
RES 100 OHM 1% 1/10W 0603	R1, R2, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R75	Yageo	RC0603FR-07100RL	Digi-Key	311-100HRCT-ND	0.03	16	\$ 0.52
RES 0.0 OHM 1/4W 0603	R4	Vishay Dale	CRCW0603000020EAHP	Digi-Key	541-0-SBCT-ND	0.23	1	\$ 0.23
RES 4.7K OHM 1% 1/10W 0603	R5, R6, R7, R8	Yageo Phycomp	RC0603FR-074K7L	Digi-Key	311-4.70KHRC-ND	0.14	4	\$ 0.54
RES 1.4K OHM 1% 1/10W 0603	R9	Yageo	RC0603FR-071K4L	Digi-Key	311-1.40KHRC-ND	0.14	1	\$ 0.14
RES 604 OHM 1% 1/10W 0603	R13	Yageo	RC0603FR-07604RL	Digi-Key	311-604HRCT-ND	0.14	1	\$ 0.14
RES 100K OHM 5% 1/8W 0603	R14, R15	Yageo	RC0603JR-07100KL	Digi-Key	311-100KGRC-ND	0.14	2	\$ 0.27
RES 3.3K OHM 1% 1/4W 0603	R16, R17, R22, R23, R28, R29, R34, R35, R40, R41, R46, R47	Panasonic	ERJPA3F3301V	Digi-Key	P3.3KBYCT-ND	0.2	12	\$ 2.35
RES 33 OHM 5% 1.5W 2512	R18, R19, R20, R21, R24, R25, R26, R27, R30, R31, R32, R33, R36, R37, R38, R39, R42, R43, R44, R45, R48, R49, R50, R51	Stackpole Electronics	RPC2512JT33R0	Digi-Key	RPC2512JT33R0CT-ND	0.55	24	\$ 13.19
RES 62 OHM 0.1% 1/10W 0603	R67, R68, R69, R70	Panasonic	ERA-3AEB620V	Digi-Key	P62DBCT-ND	0.48	4	\$ 1.90
RES ARRAY 10K OHM 0.1% 4RES 1206	R71, R72, R73, R74	Vishay Beyschlag	ACASA100251002P100	Digi-Key	749-1023-1-ND	1.09	4	\$ 4.35
NTC THERMISTOR 10K 1% BEAD	RT1	Murata	NXRT15XH103FA1B030	Digi-Key	490-8601-ND	0.95	1	\$ 0.95
IC MONITOR BATT STACK 48SSOP	U1	Analog Devices / Linear Technology	LTC6804IG-1#PBF	Digi-Key	LTC6804IG-1#PBF-ND	25.94	1	\$ 25.94
IC MUX/DEMUX 1X16 24SSOP	U2	Texas Instruments	CD74HC4067SM96	Digi-Key	296-9226-1-ND	1.2	1	\$ 1.20
IC OP AMP GEN PURPOSE RR 10MHZ SOT-23-5	U3	Texas Instruments	TLV316QDBVRQ1	Digi-Key	296-45323-1-ND	1.16	1	\$ 1.16
IC PULSE XFMR 1CT:1CT 350UH SMD	XFMR1	Bourns	PT61018AAPEL-S	Digi-Key	PT61018AAPEL-SCT-ND	2.52	1	\$ 2.52
							Total:	\$ 105.74





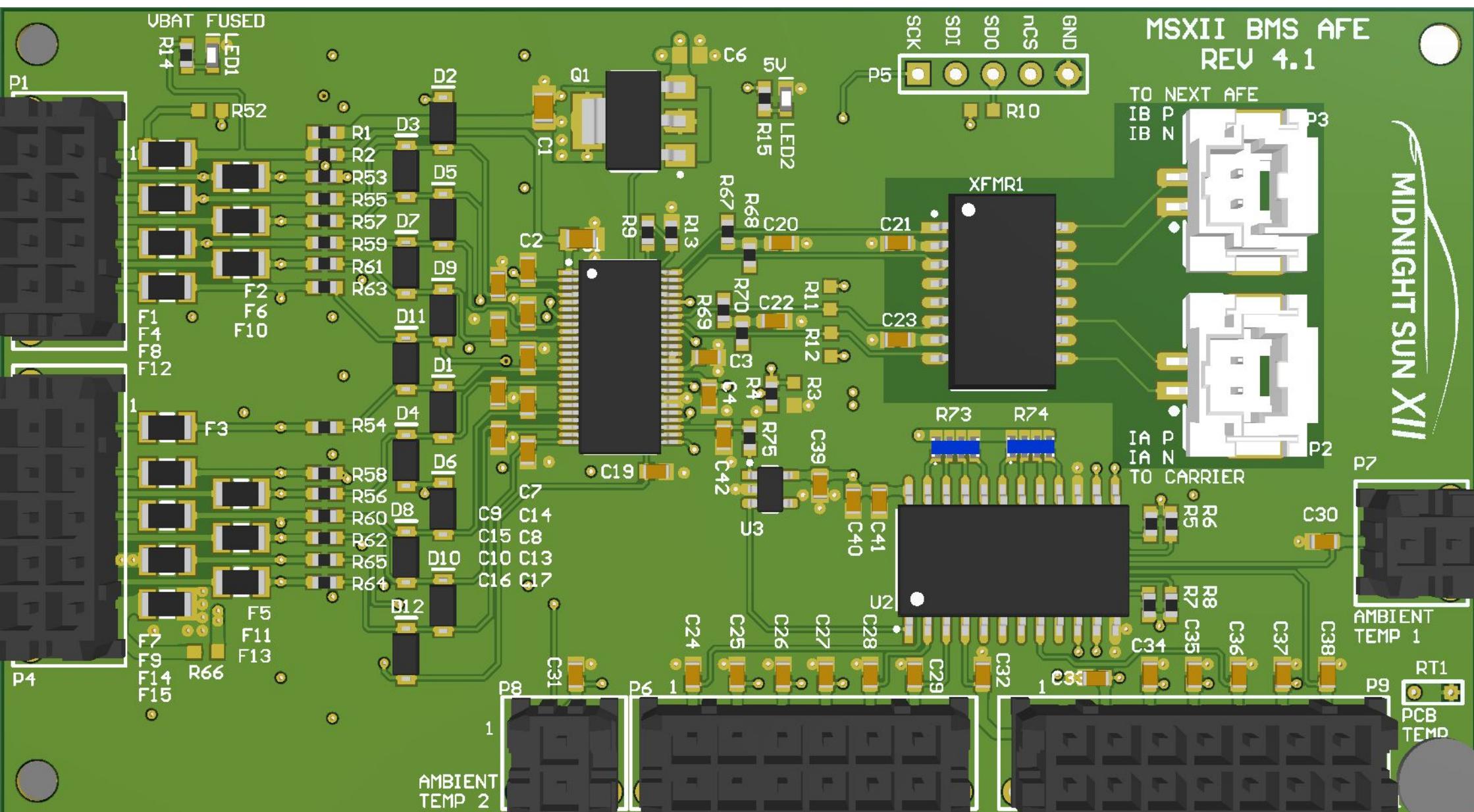


MS4005 REV 4.1



**MSXII BMS AFE**  
**REV 4.1**

MIDNIGHT SUN XII

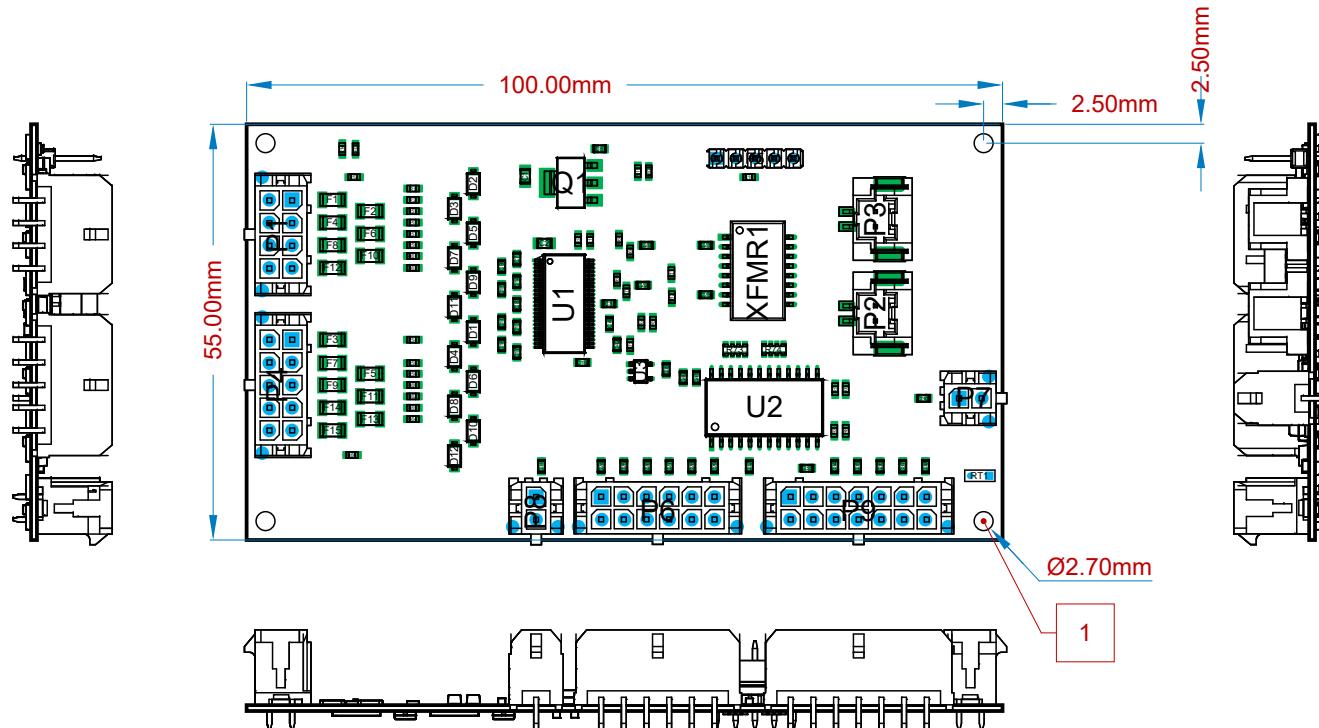


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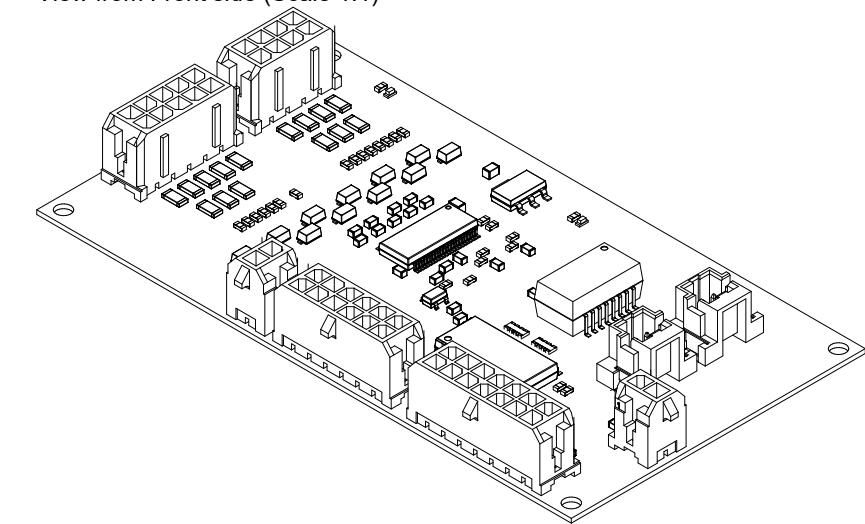
B

C

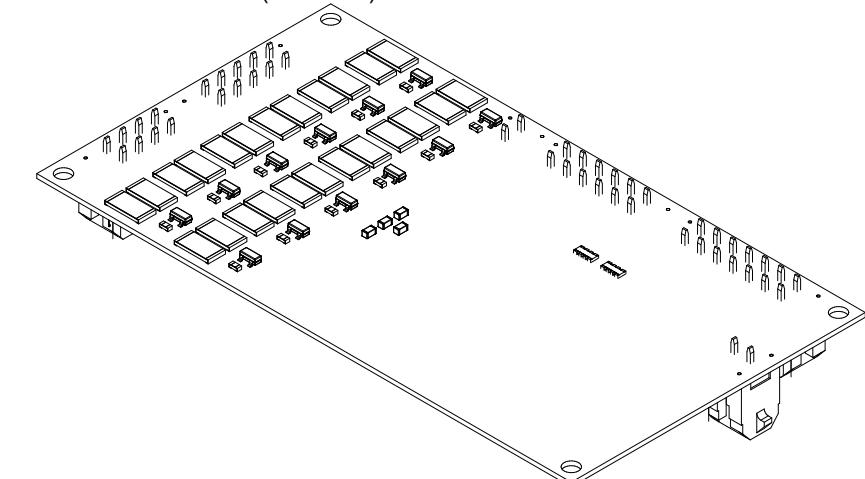
D



View from Front side (Scale 1:1)



View from Back side (Scale 1:1)



1 Use with M2.5 screws

2 Keep at least 5mm clearance to the surface below for cooling. Keep out area size is approximate.

THE INFORMATION CONTAINED IN  
THIS DRAWING IS THE SOLE  
PROPERTY OF  
Midnight Sun Solar Car Team. ANY  
REPRODUCTION IN PART OR AS A  
WHOLE WITHOUT THE WRITTEN  
PROPRIETARY AND CONFIDENTIAL

		UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		NAME	DATE	Midnight Sun Solar Car Team	
		DRAWN	Taping Li	2018-12-22			
		CHECKED				TITLE	
		ENG APPR.					
		MFG APPR.				BMS AFE Rev 4	
		Q.A.					
		COMMENTS:				SIZE DWG. NO.	
		MATERIAL					
	NEXT ASSY	USED ON	FINISH			MS40005	
	APPLICATION		DO NOT SCALE DRAWING			SCALE: 1:1	WEIGHT:
	SHEET 1 OF 1						

## Electrical Rules Check Report

Class	Document	Message
Warning	BMS AFE - Thermistors.SchDoc	FUSED_VBAT- contains Input Pin and Unspecified Port objects (Pin U2-15,Port FUSED_VBAT-)
No Report	BMS AFE - Communications.SchDoc	Net IB_N has no driving source (Pin R68-2,Pin U1-47,Pin XFMR1-3)
No Report	BMS AFE - Communications.SchDoc	Net IB_P has no driving source (Pin R67-1,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 NetR3_2 has no driving source (Pin R3-2,Pin R4-1,Pin U1-40)
No Report	BMS AFE - AFE.SchDoc	Net NetR9_1 has no driving source (Pin R9-1,Pin U1-45)
No Report	BMS AFE - AFE.SchDoc	Net NetR9_2 has no driving source (Pin R9-2,Pin R13-1,Pin U1-46)
Warning	BMS AFE - AFE.SchDoc	NetU1_27 contains IO Pin and Input Port objects (Port AFE_TEMPERATURE_SENSE)

## Design Rules Verification Report

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 4.1" (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