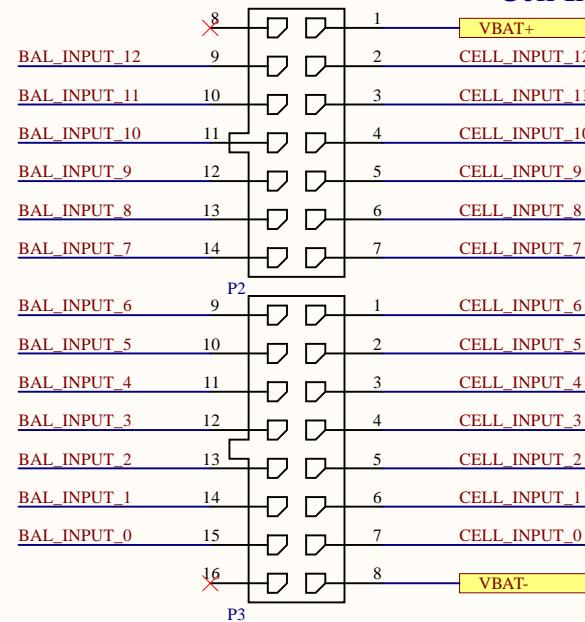


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Top Sheet.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Liam Hawkins	REVISION 1.0
LAST MODIFIED	2020-01-13	SHEET 1 OF 7

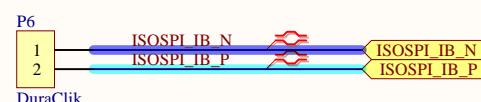
## Cell Inputs



**CELL INPUT [0..12]** → **CELL INPUT [0..12]**

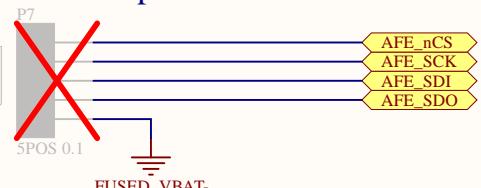
**BAL INPUT [0..12]** → **BAL INPUT [0..12]**

## isoSPI Connectors



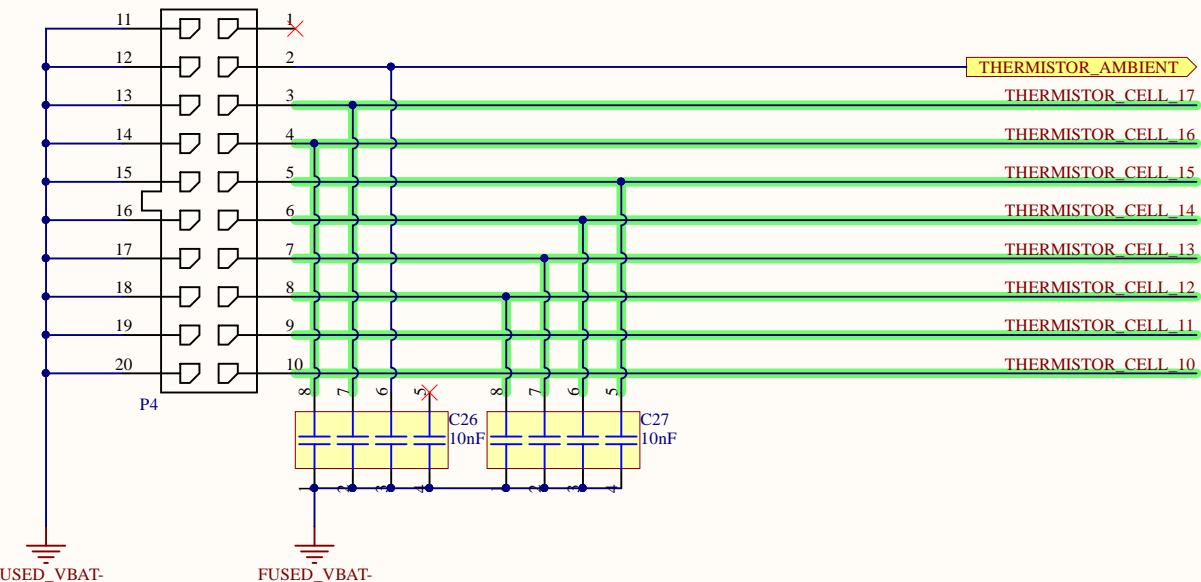
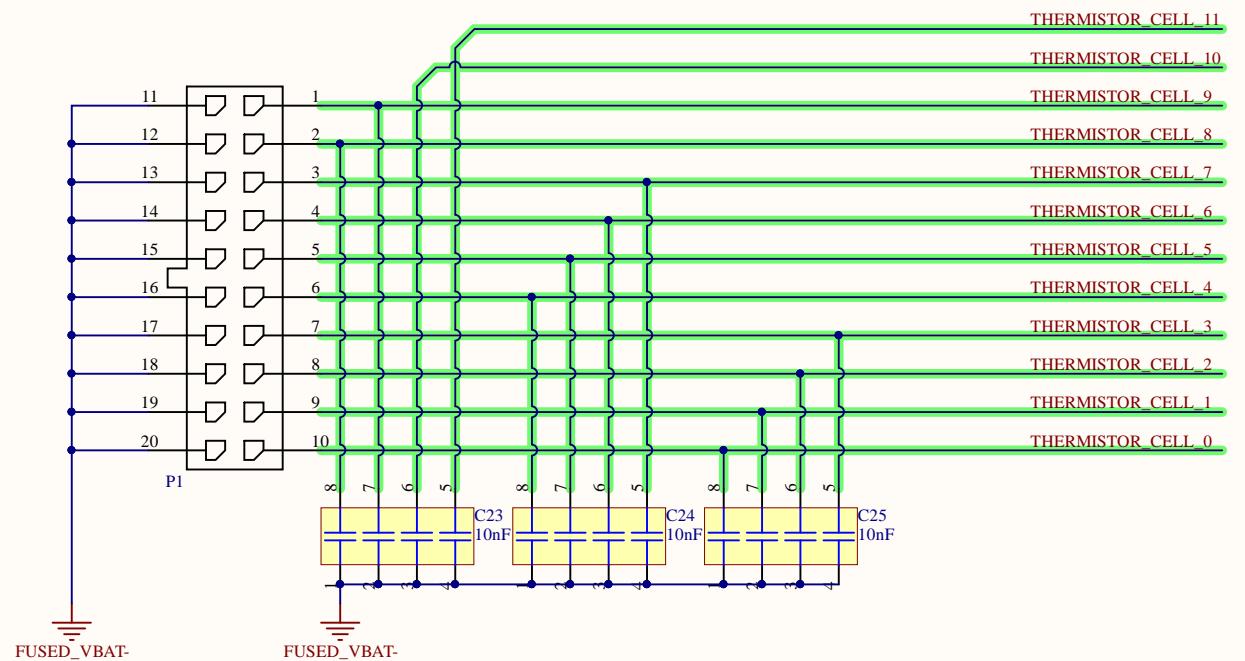
## Optional 4-wire SPI

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

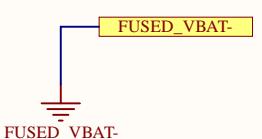


FUSED\_VBAT-

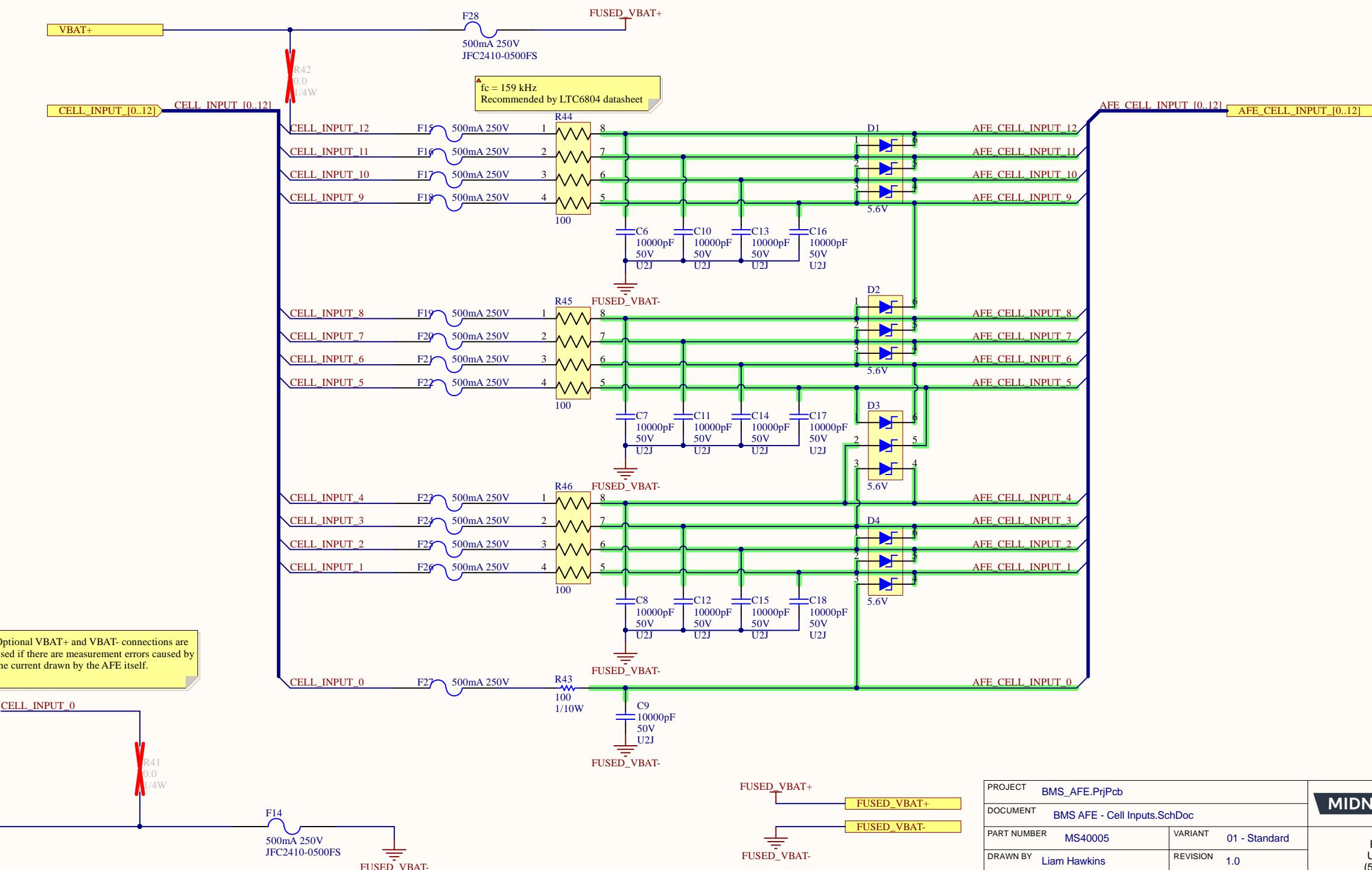
## Cell Thermistors



**THERMISTOR\_CELL [0..17]** → **THERMISTOR\_CELL [0..17]**



PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Connectors.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Liam Hawkins	REVISION 1.0
LAST MODIFIED	2020-01-13	SHEET 2 OF 7

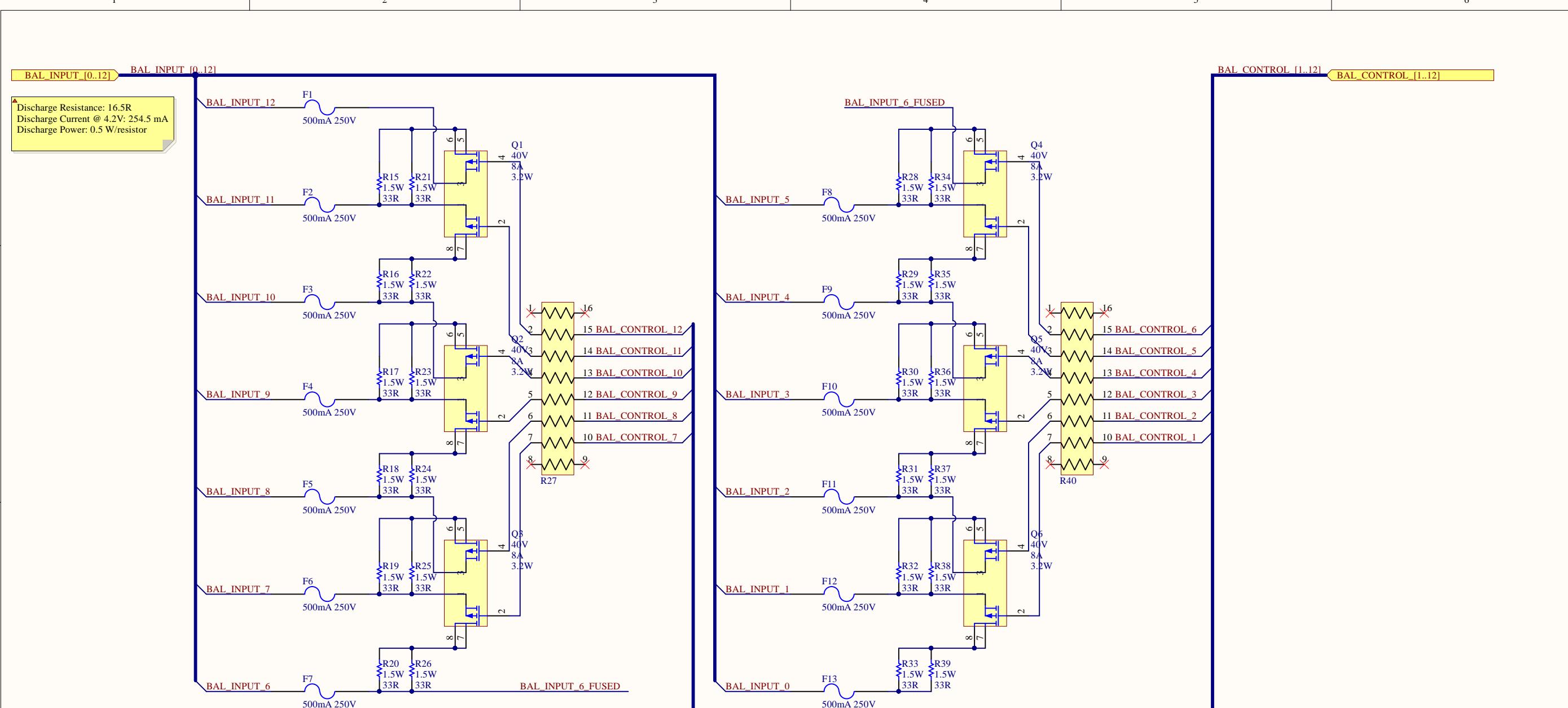


FUSED_VBAT+		PROJECT	BMS_AFE.PrtPcb
		DOCUMENT	BMS AFE - Cell Inputs.SchDoc
FUSED_VBAT-		PART NUMBER	MS40005
		VARIANT	01 - Standard
DRAWN BY	Liam Hawkins	REVISION	1.0
LAST MODIFIED	2020-01-13	SHEET	3 OF 7

**MIDNIGHT SUN**

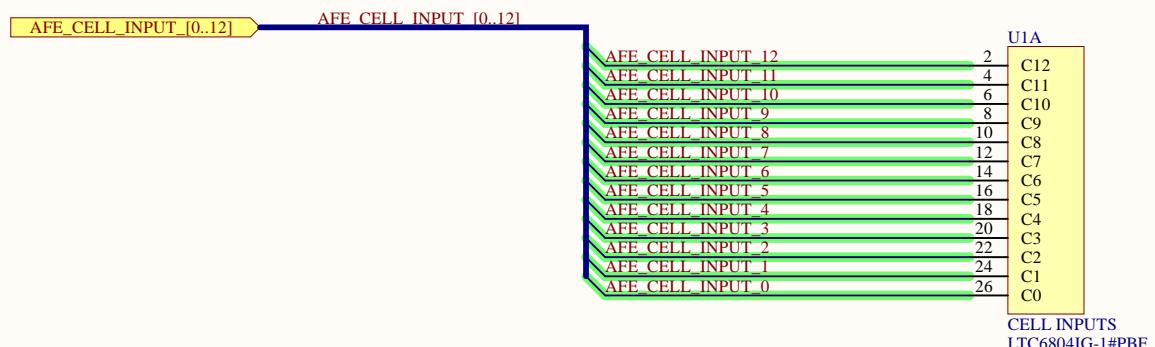


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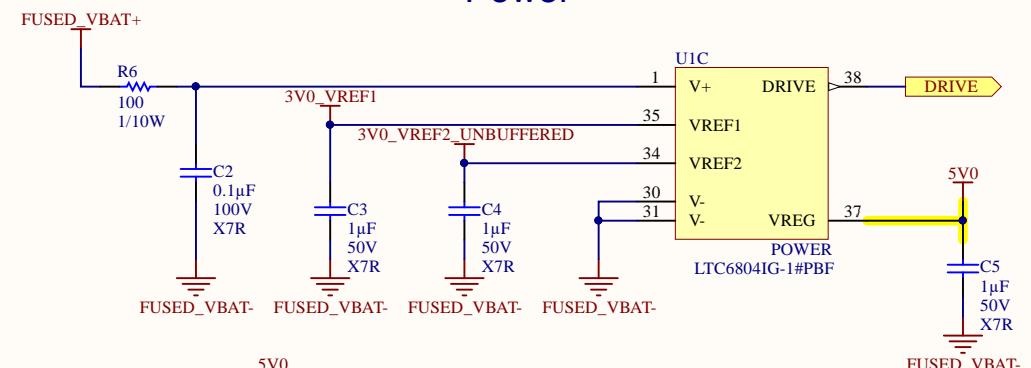


PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Cell Balancing.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Liam Hawkins	REVISION 1.0
LAST MODIFIED	2020-01-13	SHEET 4 OF 7

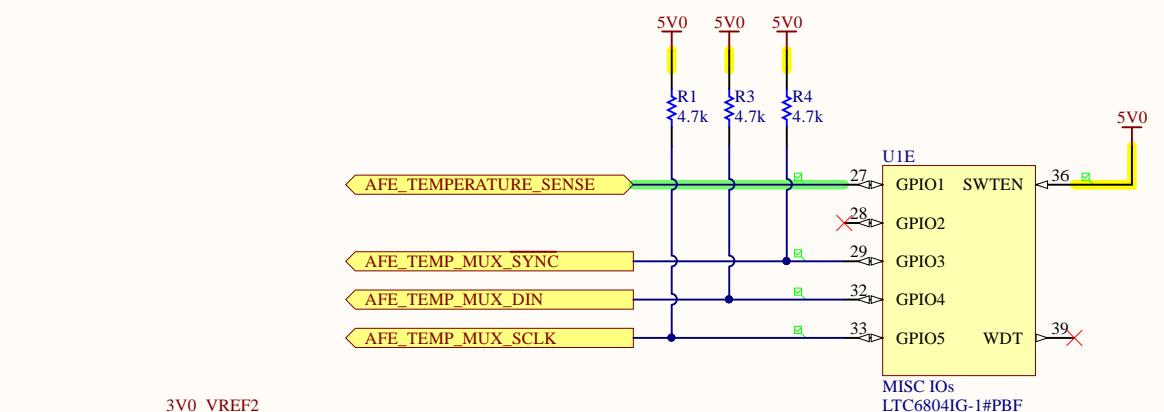
## Cell & Balancing Inputs



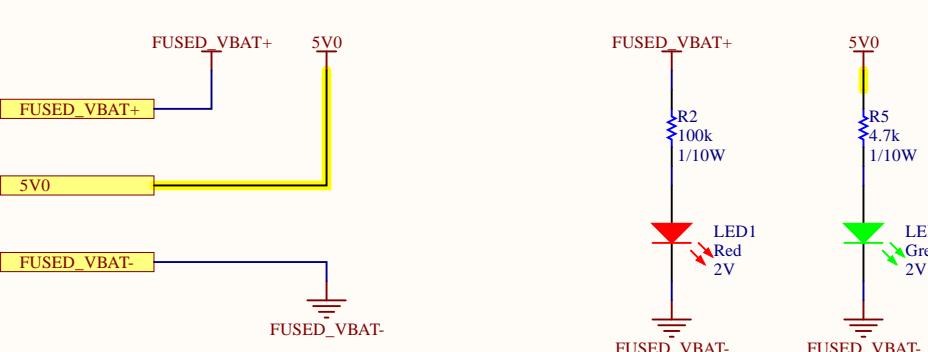
## Power



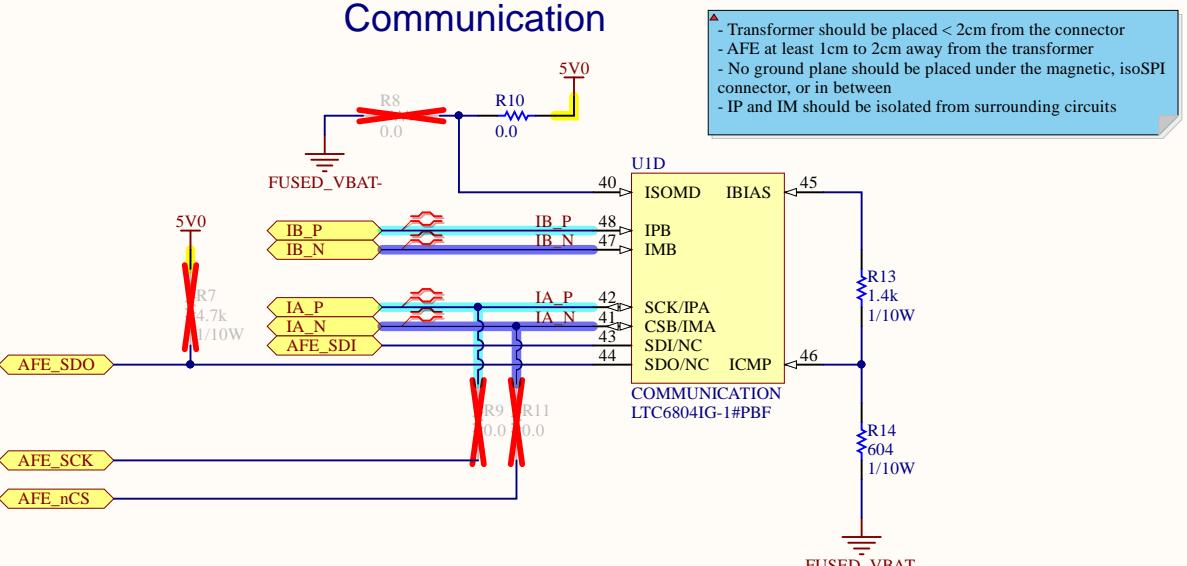
## GPIOs



## LEDs

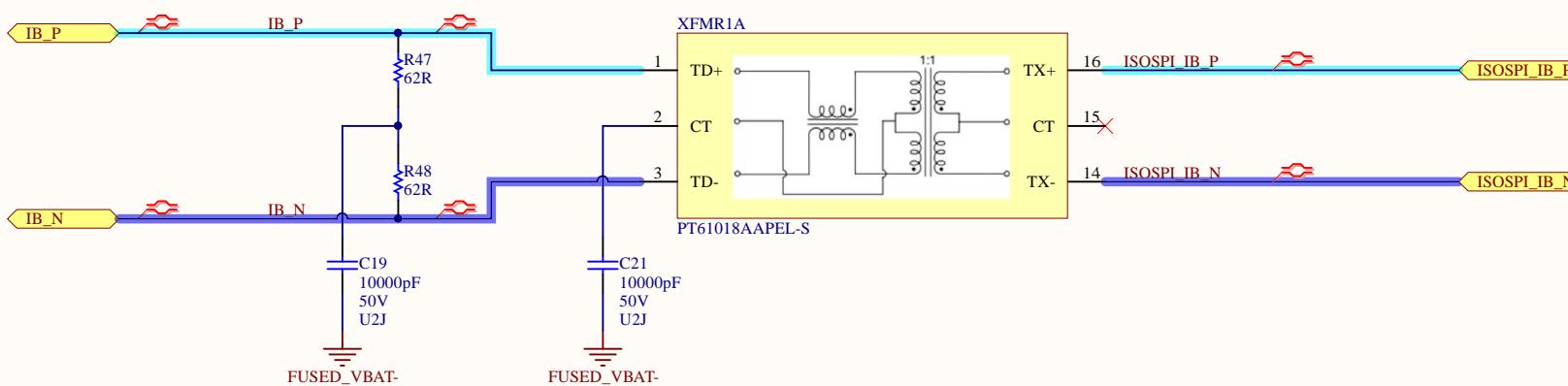


## Communication

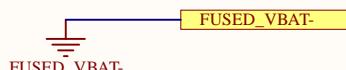
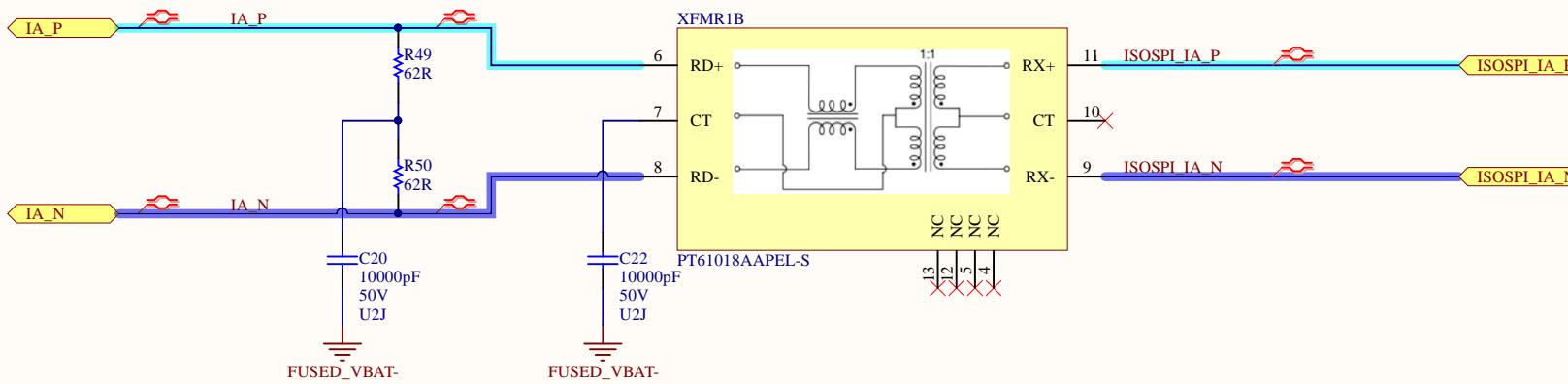


## isoSPI

## MASTER - TO NEXT AFE



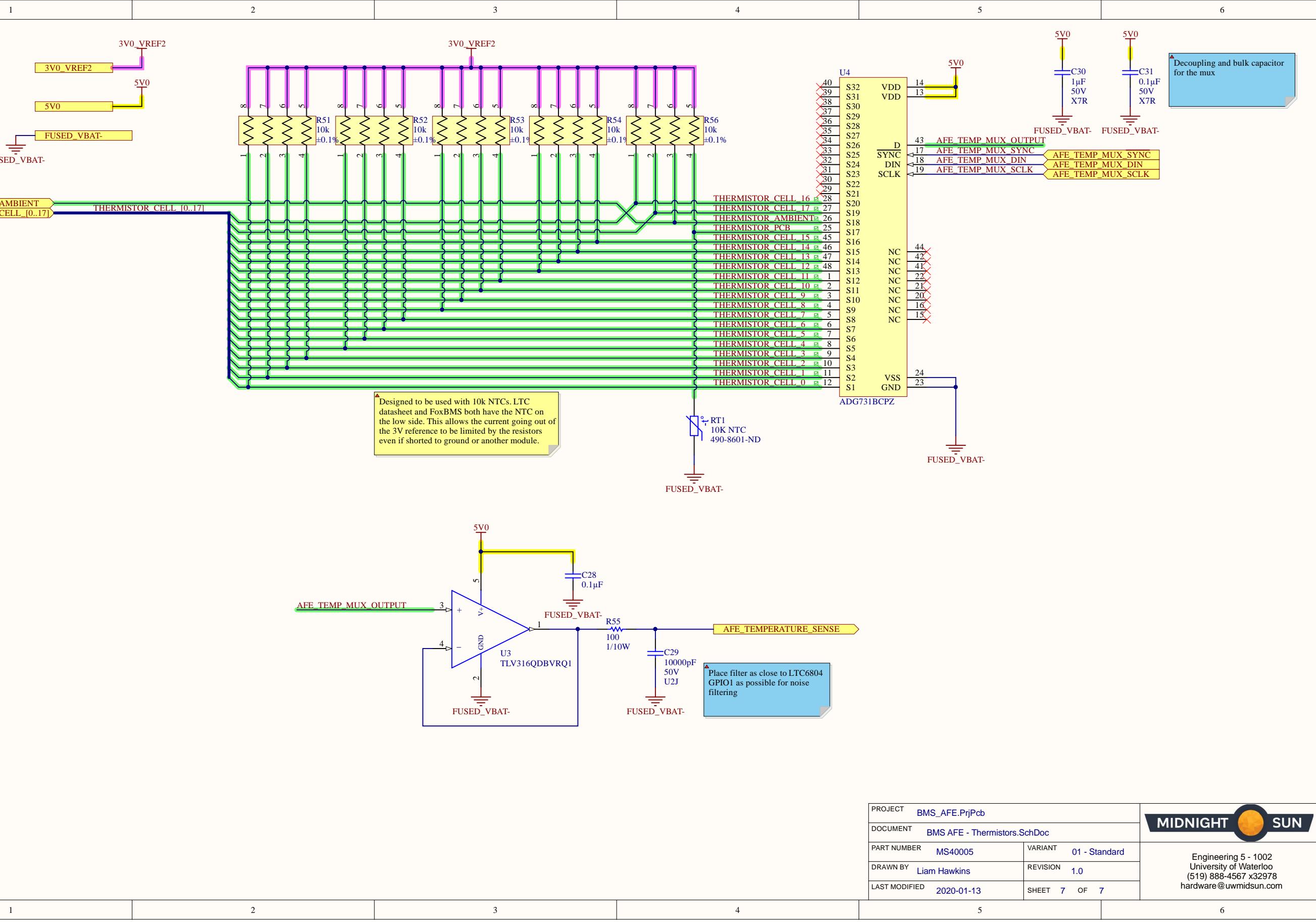
## SLAVE - FROM LTC6820



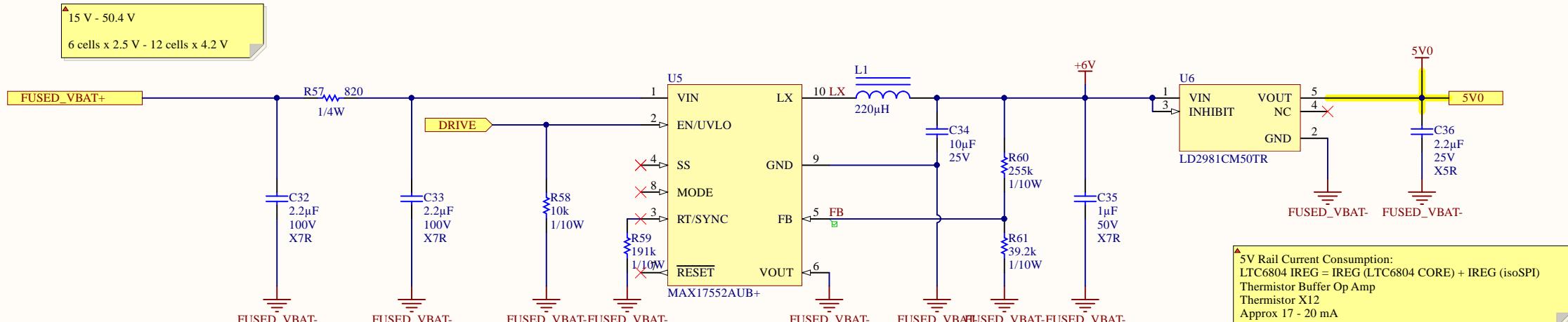
PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	BMS AFE - Communications.SchDoc	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Liam Hawkins	REVISION 1.0
LAST MODIFIED	2020-01-13	SHEET 6 OF 7

MIDNIGHT SUN

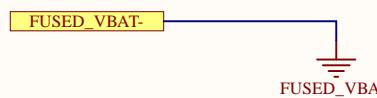
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 (519) 888-4567 x32978  
 hardware@uwmidsun.com



A



B



C

D

PROJECT	BMS_AFE.PrjPcb	
DOCUMENT	Title	
PART NUMBER	MS40005	VARIANT 01 - Standard
DRAWN BY	Liam Hawkins	REVISION 1.0
LAST MODIFIED	2020-01-13	SHEET * OF *



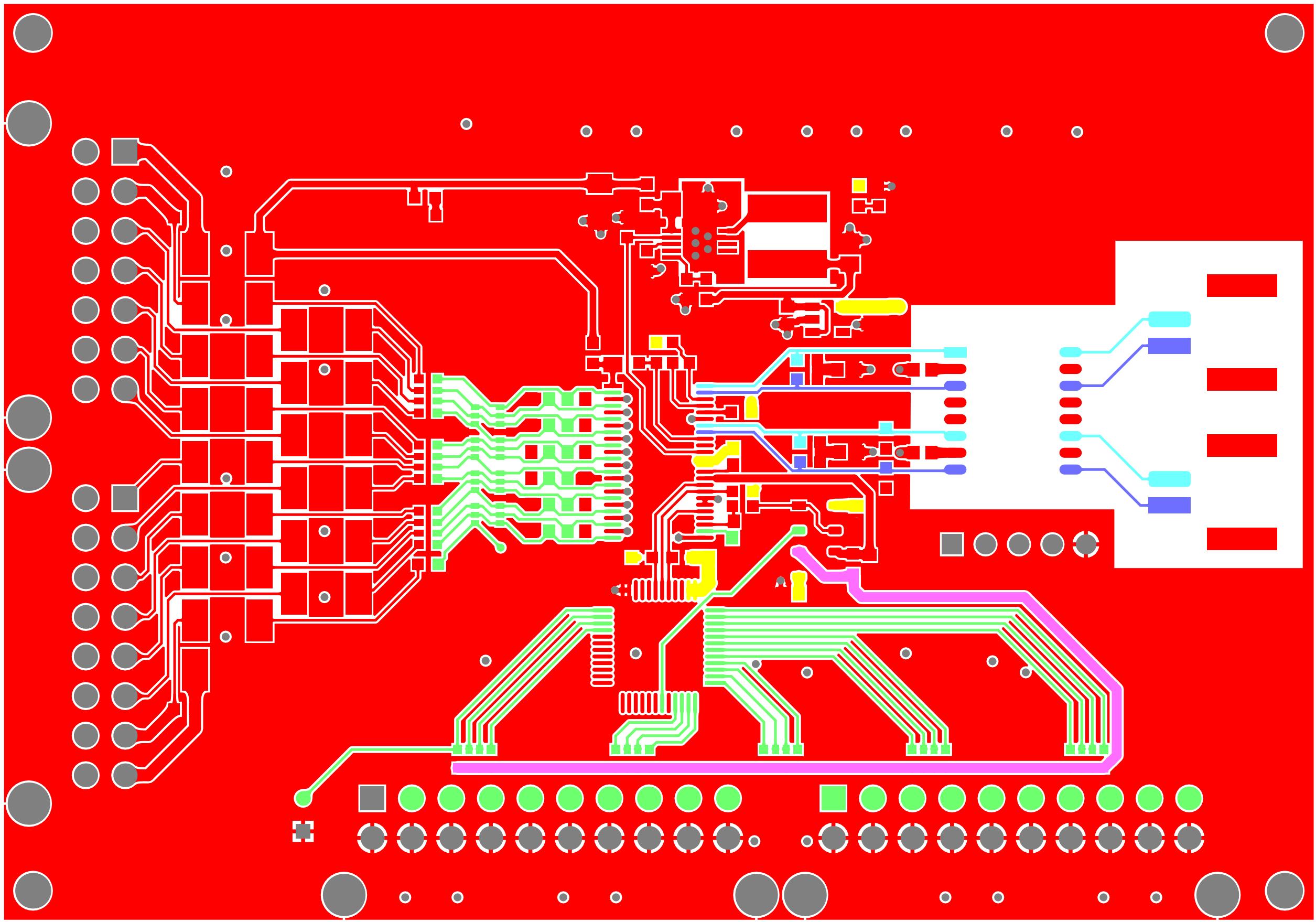
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hardware@uwmidsun.com

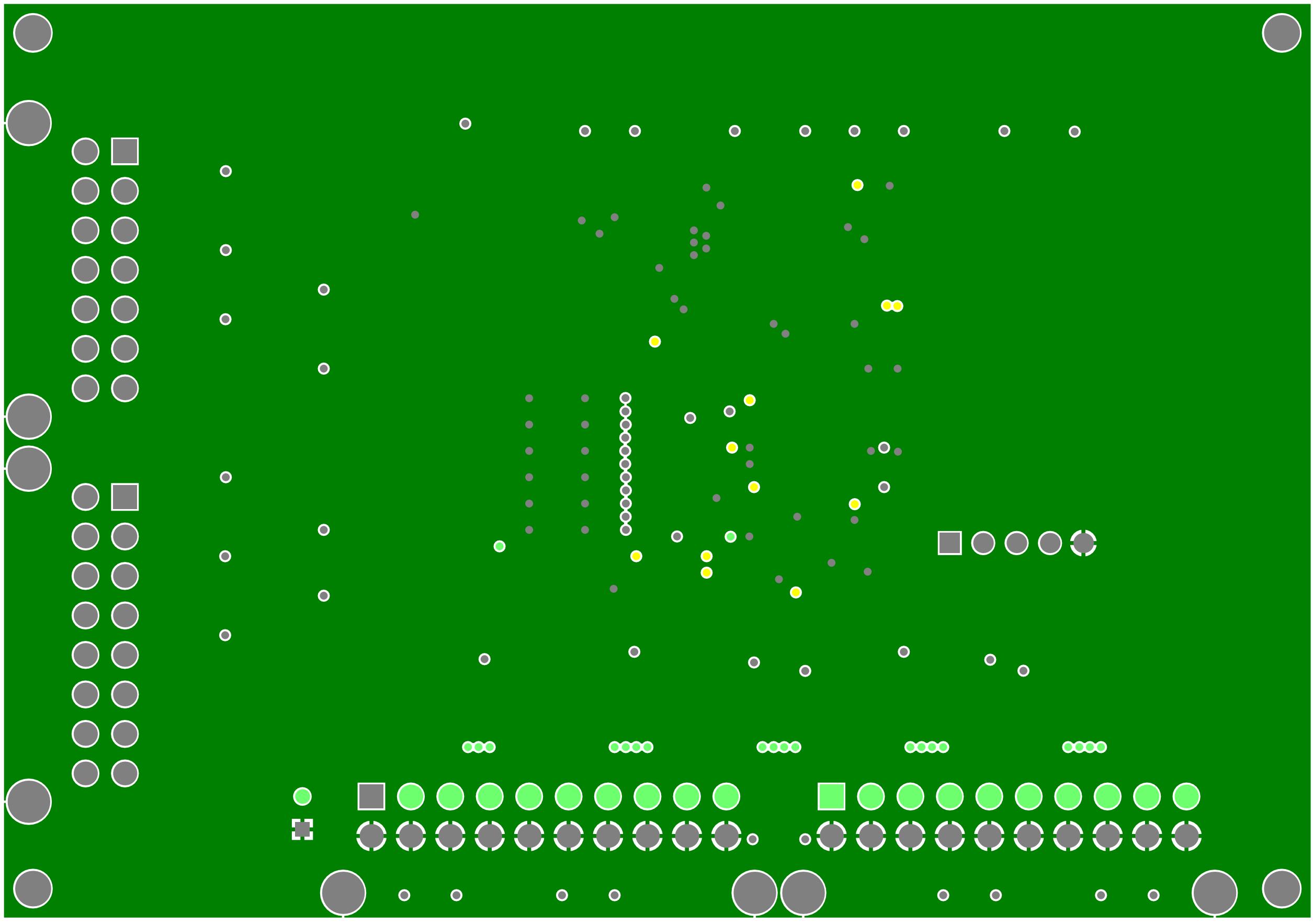
## Bill of Materials

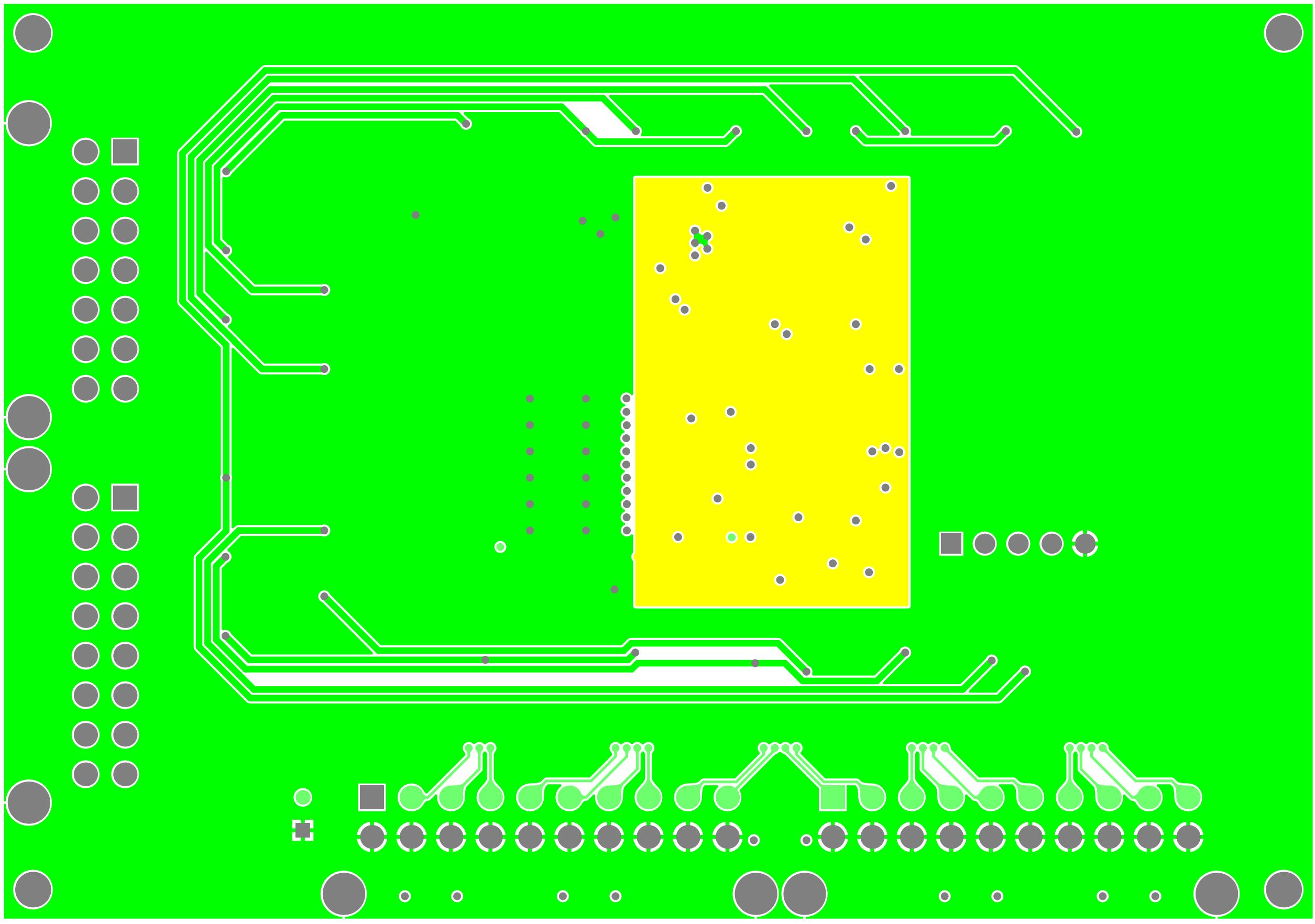
Project:	BMS_AFE.PrjPcb
Revision:	1.0
Project Lead:	Liam Haw kins
Generated On:	2020-01-13 10:37 PM
Production Quantity:	1
Currency	CAD
Total Parts Count:	145

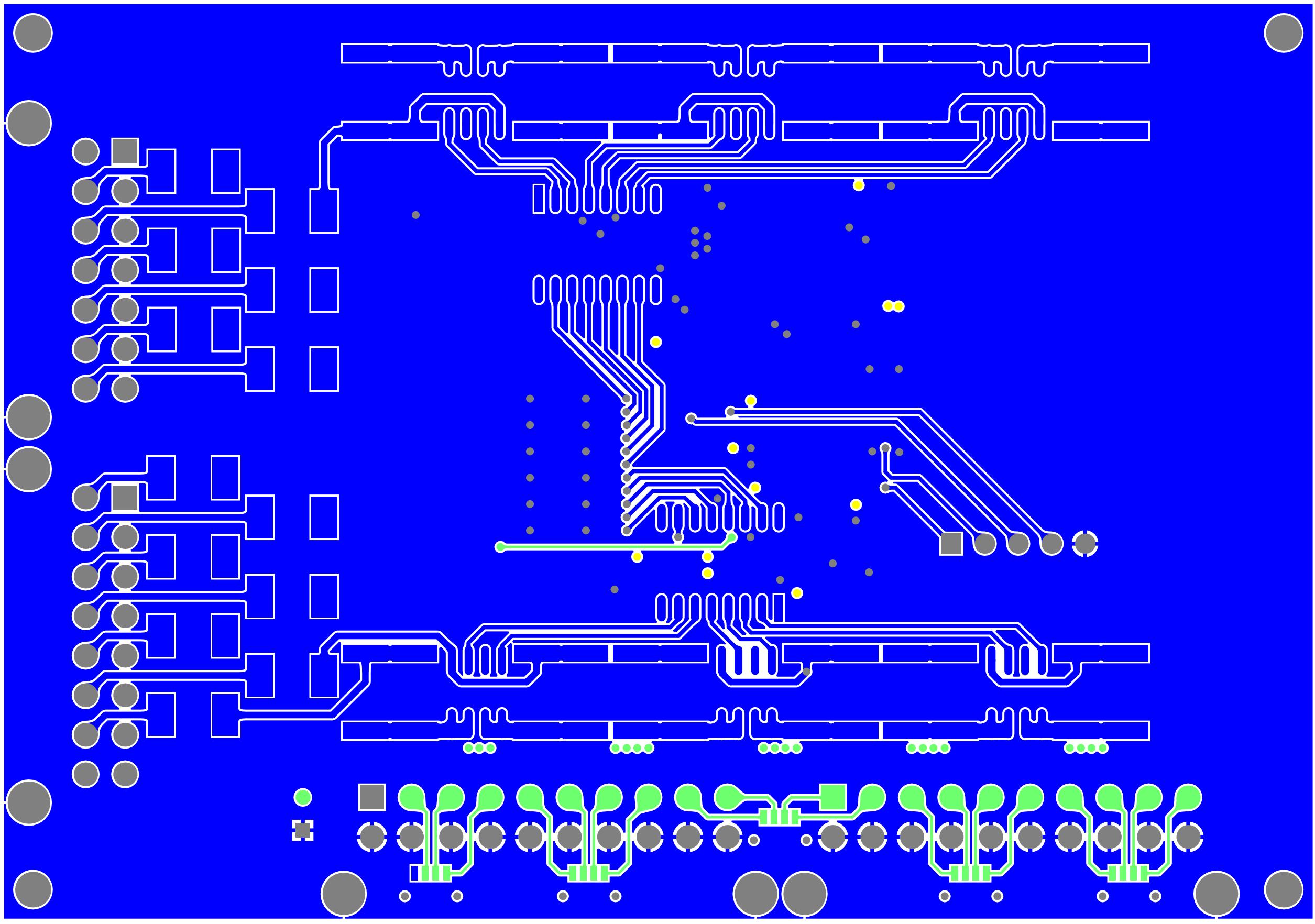
MIDNIGHT SUN

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 50V 10% X7R 0603	C1, C28, C31	Kyocera AVX	0603C5104KAT2A	Digi-Key	478-5052-1-ND	0.19573	3	\$ 0.59
CAP CER 0.1UF 100V 10% X7R 0805	C2	Murata	GCM21BR72A104KA37L	Digi-Key	490-4789-1-ND	0.39146	1	\$ 0.39
CAP CER 1UF 50V 10% X7R 0603	C3, C4, C5, C30, C35	Taiyo Yuden	UMK107AB7105KA-T	Digi-Key	587-3247-1-ND	0.32622	5	\$ 1.63
CAP CER 10nF 50V 5% X7R 0603	C11, C12, C13, C14, C15, C16, C17, C18, C19	KEMET	C0603C103J5ACTU	Digi-Key	399-13384-1-ND	0.29229	18	\$ 5.26
CAP ARRAY 10000PF 50V X7R 0612	C23, C24, C25, C26, C27	Yageo	CA0612KRX7R9BB103	Digi-Key	311-2074-1-ND	0.535	5	\$ 2.67
CAP CER 2.2UF 100V ±20% X7R 1206	C32, C33	Murata	GRM31CR72A225MA73L	Digi-Key	490-12773-1-ND		2	
CAP CER 10uF 25V 10% X5R 0805	C34	Murata	GRM21BR61E106KA73L	Digi-Key	490-5523-1-ND	0.54805	1	\$ 0.55
CAP CER 2.2UF 25V 10% X5R 0603	C36	Murata	GRM188R61E225KA12D	Digi-Key	490-10731-1-ND	0.22183	1	\$ 0.22
DIODE ZENER ARRAY 5.6V SOT363	D1, D2, D3, D4	Diodes	BZX84C5V6TS-7-F	Digi-Key	BZX84C5V6TS-FDICT-N	0.54805	4	\$ 2.19
FUSE 500mA LSC	, F12, F13, F14, F15, F16, F17, F18, F19, F20	Shenzen JDTFuse	JFC2410-0500FS	LCSC	C136360		28	
IND 220uH 0.59A 20%	L1	Laird Steward	TY-S6045221M-10	Digi-Key	240-2742-1-ND	0.87426	1	\$ 0.87
LED RED CLEAR 2V 0603	LED1	Wurth Electronics	150060RS75000	Digi-Key	732-4978-1-ND	0.18268	1	\$ 0.18
LED GREEN CLEAR 2V 0603	LED2	Wurth Electronics	150060VS75000	Digi-Key	732-4980-1-ND	0.18268	1	\$ 0.18
CONN R/A 20POS 3MM	P1, P4	Molex	0430452021	Digi-Key	WM20137-ND	7.41	2	\$ 14.82
CONN R/A 14POS 3MM	P2	Molex	0430451421	Digi-Key	WM14571-ND	5.38	1	\$ 5.38
CONN R/A 16POS 3MM	P3	Molex	0430451621	Digi-Key	WM14573-ND	5.98	1	\$ 5.98
CONN 2POS DURA-CLIK 0.079"	P5, P6	Molex	5023520200	Digi-Key	WM7169CT-ND	1.64	2	\$ 3.29
MOSFET DUAL P-CH 40V 8A 3.2W 8-SOIC	Q1, Q2, Q3, Q4, Q5, Q6	Vishay Siliconix	S14909DY-T1-GE3	Digi-Key	SI4909DY-T1-GE3CT-N	1.33	6	\$ 7.99
R ES 4.7K OHM 1% 1/10W 0603	R1, R3, R4, R5	Yageo Phycomp	RC0603FR-074K7L	Digi-Key	311-4.70KHRC-TND	0.13049	4	\$ 0.52
R ES 100K OHM 5% 1/8W 0603	R2	Yageo	RC0603JR-07100KL	Digi-Key	311-100KGRC-TND	0.13049	1	\$ 0.13
R ES 100 OHM 1% 1/10W 0603	R6, R43, R55	Yageo	RC0603FR-07100RL	Digi-Key	311-100HRCT-N	0.13049	3	\$ 0.39
RES 0.0OHM 1/4W 0603	R10	Vishay Dale	CRCW0603000020EAHP	Digi-Key	541-0.0SBCT-N	0.19573	1	\$ 0.20
RES 1.4kOHM 1% 1/10W 0603	R13	Yageo	RC0603FR-071K4L	Digi-Key	311-1.40KHRC-TND	0.13049	1	\$ 0.13
RES 604 OHM 1% 1/10W 0603	R14	Yageo	RC0603FR-07604RL	Digi-Key	311-604HRCT-N	0.13049	1	\$ 0.13
RES 33 OHM 5% 1.5W 2512	2, R23, R24, R25, R26, R28, R29, R30, R31, R	Stackpole Electronics	RPC2512JT33R0	Digi-Key	RPC2512JT33R0CT-N	0.52717	24	\$ 12.65
RES ARRAY 3.3K OHM 2% 16SOIC	R27, R40	Bourns	4816P-1-332LF	Digi-Key	4816P-1-332LFCT-N	1.71	2	\$ 3.42
RES ARRAY 100 OHM 0.5% 4RES 1206	R44, R45, R46	Vishay	ACASA100021000P100	Digi-Key	ACASA-100/100-2CT-N	0.9656	3	\$ 2.90
RES 62 OHM 0.1% 1/10W 0603	R47, R48, R49, R50	Panasonic	ERA3AE8620V	Digi-Key	P62DBCT-N	0.4567	4	\$ 1.83
RES ARRAY 10K OHM 0.1% 4RES 1206	R51, R52, R53, R54, R56	Vishay Beyschlag	ACASA1002S1002P100	Digi-Key	749-1023-1-ND	1.04	5	\$ 5.22
R ES 820 OHM 5% 1/4W 0603	R57	Rohm	ESR03EZPJ821	Digi-Key	RHM820DC-TND	0.13049	1	\$ 0.13
R ES 10K OHM 1% 1/10W 0603	R58	Yageo Phycomp	RC0603FR-07100KL	Digi-Key	311-10.0KHRC-TND	0.13049	1	\$ 0.13
R ES 191K OHM 1% 1/10W 0603	R59	Yageo	RC0603JR-07191KL	Digi-Key	311-191KHRC-TND	0.13049	1	\$ 0.13
R ES 255K OHM 1% 1/10W 0603	R60	Yageo	RC0603FR-07255KL	Digi-Key	311-255KHRC-TND	0.13049	1	\$ 0.13
R ES 39.2K OHM 1% 1/10W 0603	R61	Yageo	RC0603FR-0739K2L	Digi-Key	311-39.2KHRC-TND	0.13049	1	\$ 0.13
NTC THERMISTOR 10K 1% BEAD	RT1	Murata	NXR15XH103FA1B030	Digi-Key	490-8601-ND	0.91341	1	\$ 0.91
IC MONITOR BATT STACK 48SSOP	U1	Analog Devices/Linear	LTC6804IG-1#PBF	Digi-Key	LTC6804IG-1#PBF-ND	27.69	1	\$ 27.69
COP AMP GEN PURPOSE RR 5.5MHZ SOT-23-5	U2	Texas Instruments	OPA376AQDBVRQ1	Digi-Key	296-36701-1-ND	2.79	1	\$ 2.79
COP AMP GEN PURPOSE RR 10MHZ SOT-23-5	U3	Texas Instruments	TLV316QDBVRQ1	Digi-Key	296-45323-1-ND	1.11	1	\$ 1.11
IC 32x1 Multiplexer ADG731BCPZ	U4	Analog Devices	ADG731BSUZ	Digi-Key	ADG731BSUZ-ND	13.92	1	\$ 13.92
IC REG BUCKADJ 0.1A 10UMAX	U5	Maxim	MAX17552AUB+	Digi-Key	MAX17552AUB+-ND	2.77	1	\$ 2.77
IC REG LDO 5V 0.1A SOT23-5	U6	STMicroelectronics	LD2981CM50TR	Digi-Key	497-7787-1-ND	0.84817	1	\$ 0.85
IC PULSE XFMR 1CT:1CT350UH SMD	XFMR1	Bourns	PT61018AAPEL-S	Digi-Key	PT61018AAPEL-SCT-N	5	1	\$ 5.00
					Total:			\$ 135.41







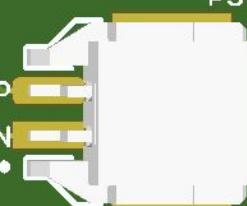


MSXIV BMS AFE  
REV 1.0

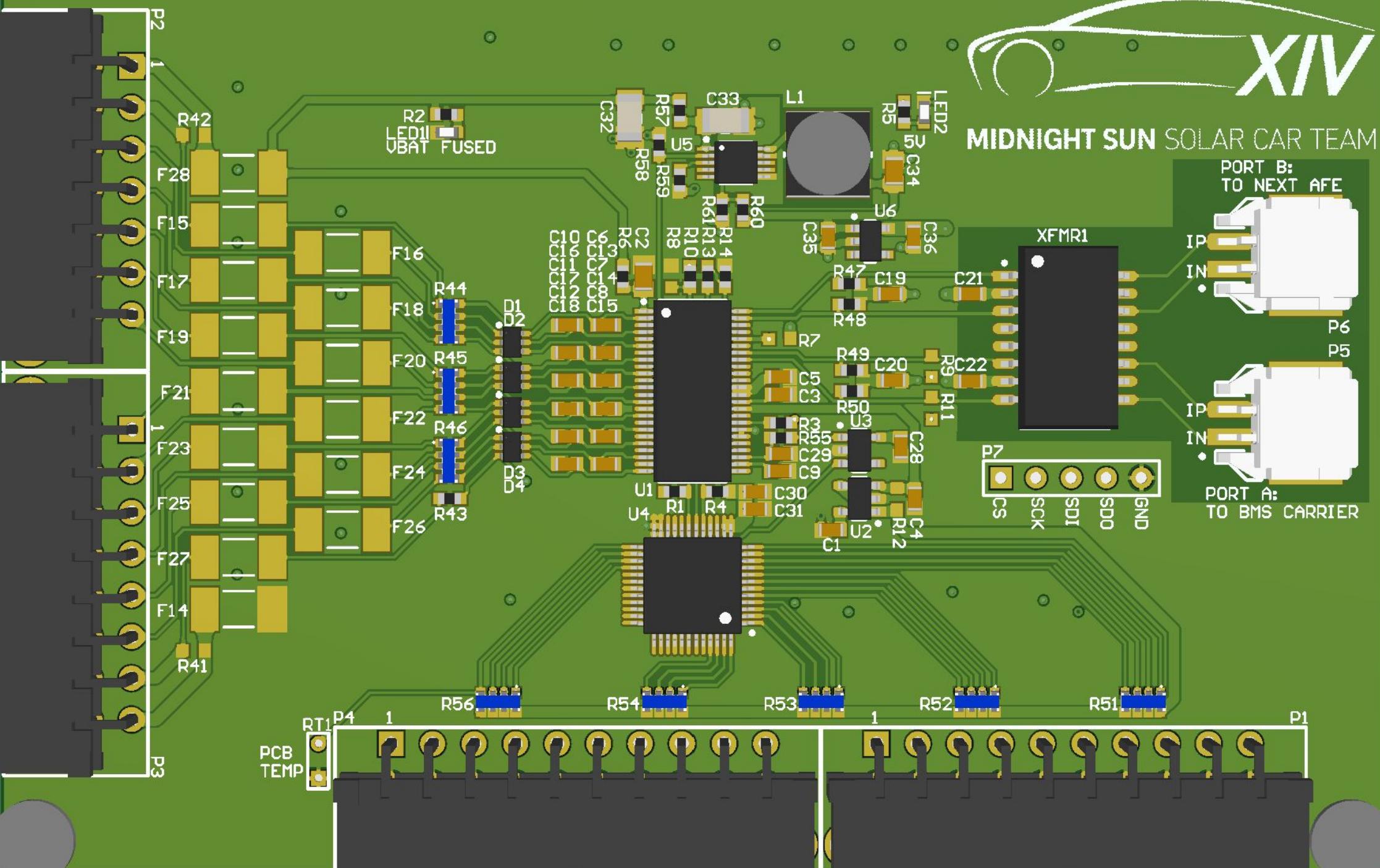


MIDNIGHT SUN SOLAR CAR TEAM

PORT B:  
TO NEXT AFE



PORT A:  
TO BMS CARRIER



## Electrical Rules Check Report

Class	Document	Message
Warning	BMS AFE - Regulator.SchDoc	FUSED_VBAT- contains Input Pin and Unspecified Port objects (Pin U5-6,Port FUSED_VBAT)
Warning	BMS AFE - Top Sheet.SchDoc	Incorrect link between project variant "01 - Standard" and schematic component Component P5 CONN_2POS DURA-CLIK 0.079"
Warning	BMS AFE - Top Sheet.SchDoc	Incorrect link between project variant "01 - Standard" and schematic component Component R2 RES_100K_OHM_5%_1/8W_0603
Warning	BMS AFE - Top Sheet.SchDoc	Incorrect link between project variant "01 - Standard" and schematic component Component R10 RES_0.0_OHM_1/4W_0603
Warning	BMS AFE - Top Sheet.SchDoc	Incorrect link between project variant "01 - Standard" and schematic component Component R51_(R56)_RES_ARRAY_10K_OHM_0.1%_4RES_1206
No Report	BMS AFE - Thermistors.SchDoc	Net AFE_TEMP_MUX_OUTPUT has no driving source (Pin U3-3,Pin U4-43)
No Report	BMS AFE - Communications.SchDoc	Net IB_N has no driving source (Pin R48-2,Pin U1-47,Pin XFMR1-3)
No Report	BMS AFE - Communications.SchDoc	Net IB_P has no driving source (Pin R47-1,Pin U1-48,Pin XFMR1-1)
No Report	BMS AFE - AFE.SchDoc	Net NetR8_2 has no driving source (Pin R8-2,Pin R10-1,Pin U1-40)
No Report	BMS AFE - AFE.SchDoc	Net NetR13_1 has no driving source (Pin R13-1,Pin U1-45)
No Report	BMS AFE - AFE.SchDoc	Net NetR13_2 has no driving source (Pin R13-2,Pin R14-1,Pin U1-46)

# Design Rules Verification Report

Filename : C:\Users\Liam\Documents\UWaterloo\Midnight Sun\Hardware Repository\hardware\MSXIV\_BMS\_AFE\AFE.PcbDoc

Warnings 0  
Rule Violations 14

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)	14
Height Constraint (Min=0mm) (Max=25.4mm) (Preferred=12.7mm) (All)	0
Total	14

Board Clearance Constraint (Gap=0mm) (All)	
Board Outline Clearance(Outline Edge): (0.152mm < 0.295mm) Between Board Edge And Text "CELL 12" (5.5mm,58.25mm) on Bottom Overlay	
Board Outline Clearance(Outline Edge): (0.1mm < 0.295mm) Between Board Edge And Text "THERMISTORS" (99.75mm,9mm) on Bottom Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (0.28mm,36.3mm)(10.7mm,36.3mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (0.28mm,36.45mm)(0.28mm,62.55mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (0.28mm,36.45mm)(10.7mm,36.45mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (0.28mm,62.55mm)(10.7mm,62.55mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (0.28mm,7.2mm)(0.28mm,36.3mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (0.28mm,7.2mm)(10.7mm,7.2mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (24.2mm,0.28mm)(24.2mm,10.7mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (24.2mm,0.28mm)(59.3mm,0.28mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (59.2mm,0.28mm)(59.2mm,10.7mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (59.2mm,0.28mm)(94.3mm,0.28mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (59.3mm,0.28mm)(59.3mm,10.7mm) on Top Overlay	
Board Outline Clearance(Outline Edge): (0.153mm < 0.295mm) Between Board Edge And Track (94.3mm,0.28mm)(94.3mm,10.7mm) on Top Overlay	