

PROJECT	BMS_Carrier_Board.PrjPcb	
DOCUMENT	Controller Board Interface	
PART NUMBER	MS-ELE0003	VARIANT BMS_Carrier_Board
DRAWN BY	Liam Hawkins	REVISION 1.1
LAST MODIFIED	2020/1/28	SHEET 1 OF 4

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SUN

Engineering 5 - 1002
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Table 4. SPI Modes

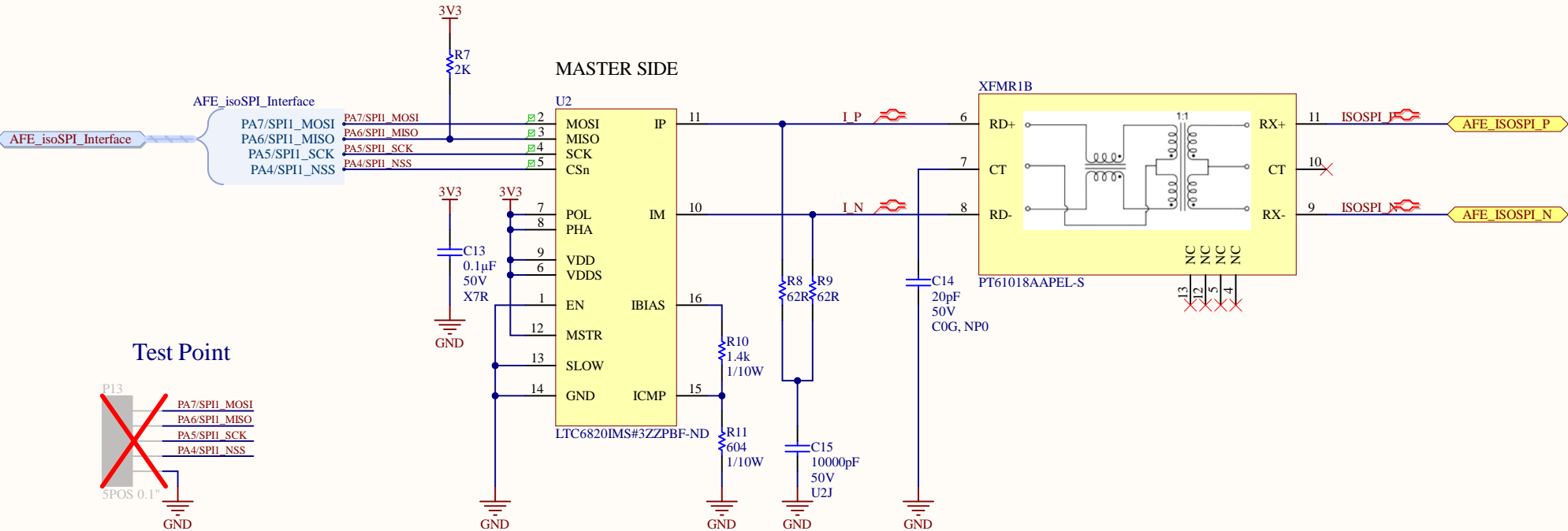
MODE	POL	PHA	DESCRIPTION
0	0	0	SCK Idles Low, Latches on Rising (1st) Edge
1	0	1	SCK Idles Low, Latches on Falling (2nd) Edge
2	1	0	SCK Idles High, Latches on Falling (1st) Edge
3	1	1	SCK Idles High, Latches on Rising (2nd) Edge

SCK idles high, latches on 2nd rising edge

Pulse Drive Current $I_{IP} = 20 \cdot I_{BIAS} = 20\text{mA}$

Transmitted Differential Signal Amplitude $V_A = I_{IP} \cdot 120/2 = 1.2\text{V}$

Bias Current I_{BIAS} can be adjusted from 0.1mA to 1mA
Currently set to 1mA

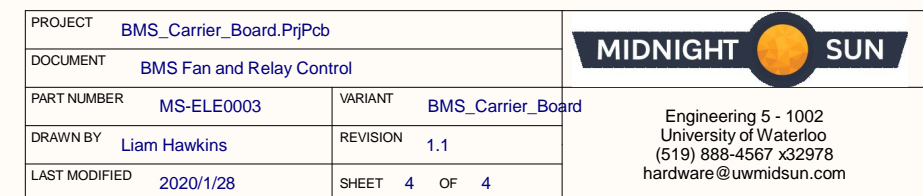


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DOCUMENT	BMS Interface	
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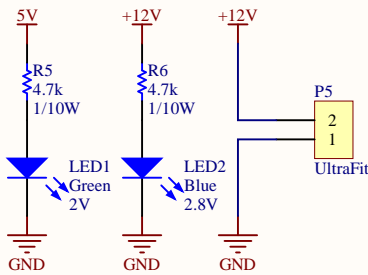
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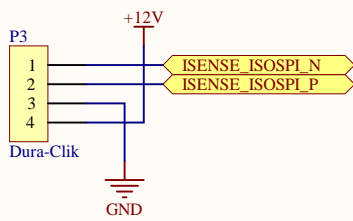
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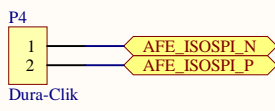
12V Power



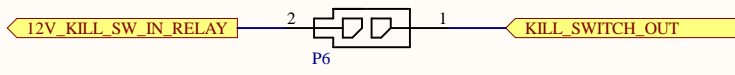
BMS Current Sense



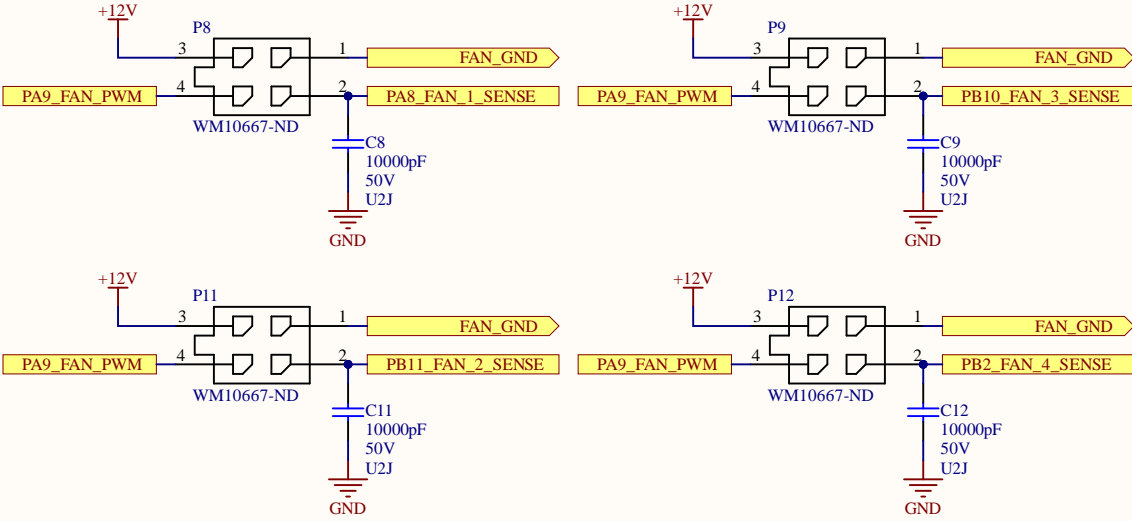
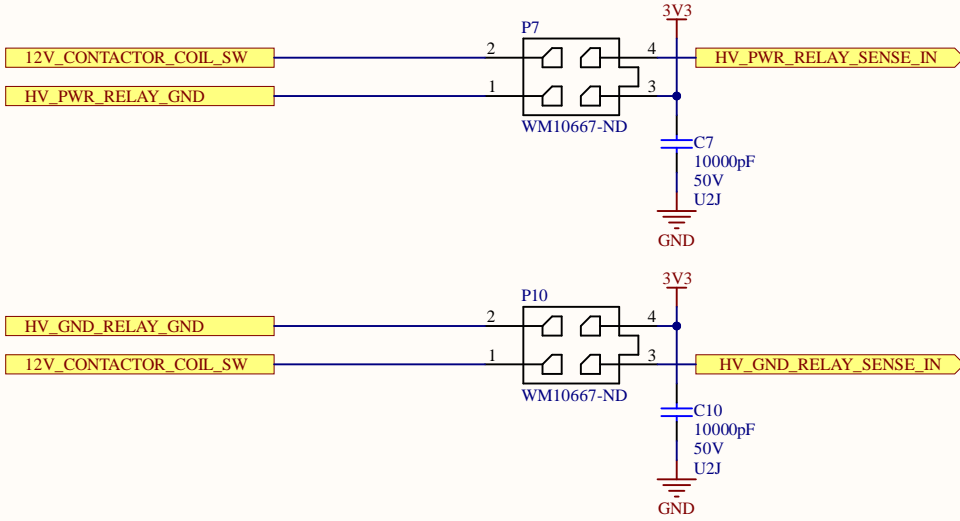
AFE isoSPI



Kill Switch



Relays & Fans



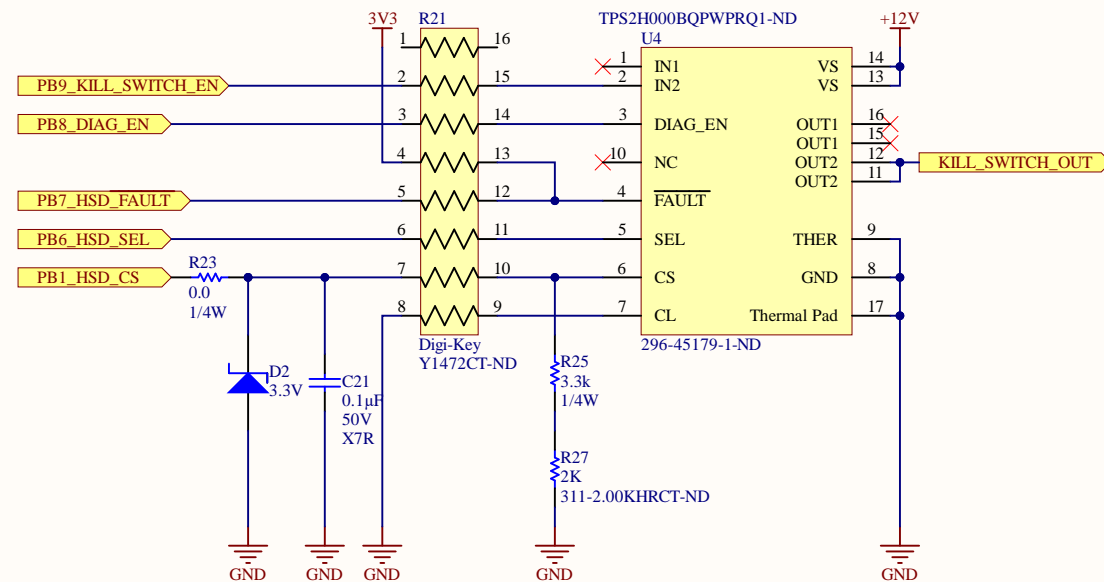
PROJECT	BMS_Carrier_Board.PrjPcb	
DOCUMENT	BMS Fan and Relay Control	
PART NUMBER	MS-ELE0003	VARIANT BMS_Carrier_Board
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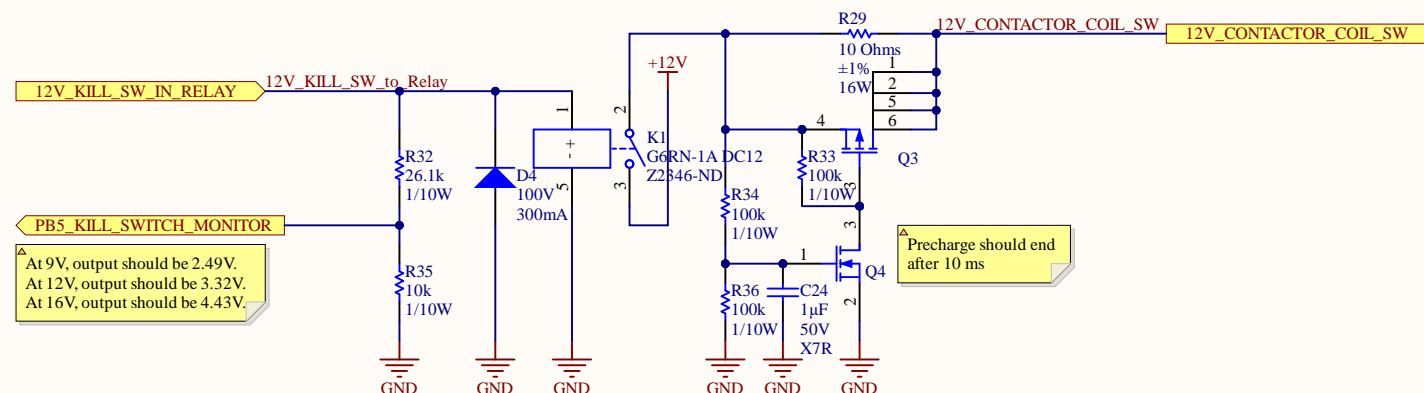
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High Side Driver to Kill Switch

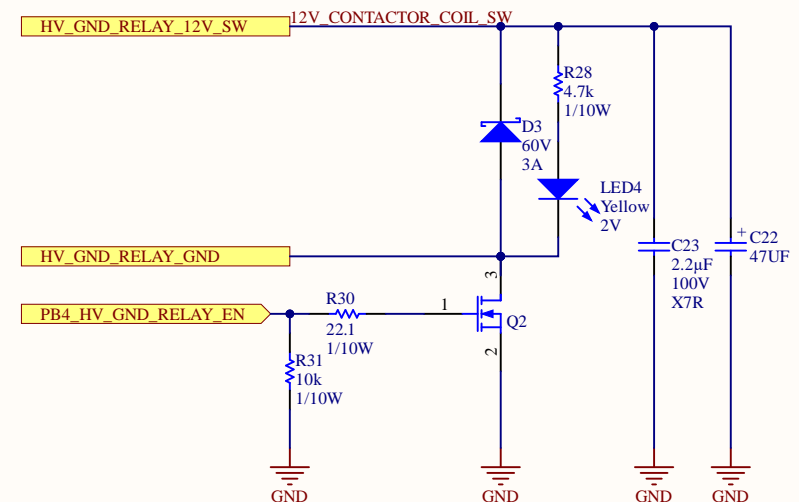
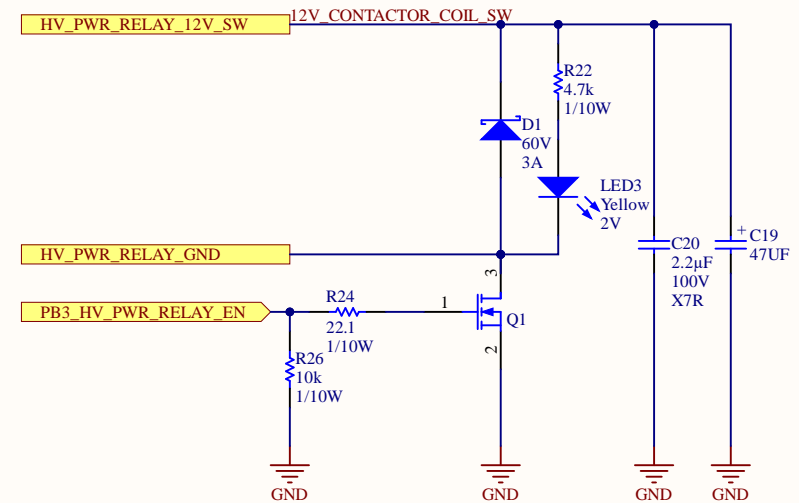



Should be high mainly (3.3 V input from MCU)

Kill Switch Relay

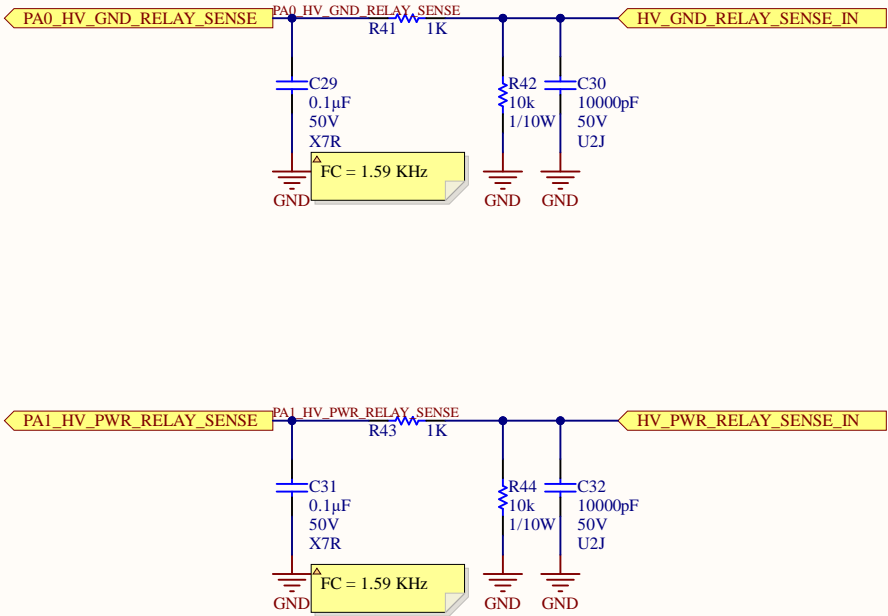



Precharge should end after 10 ms

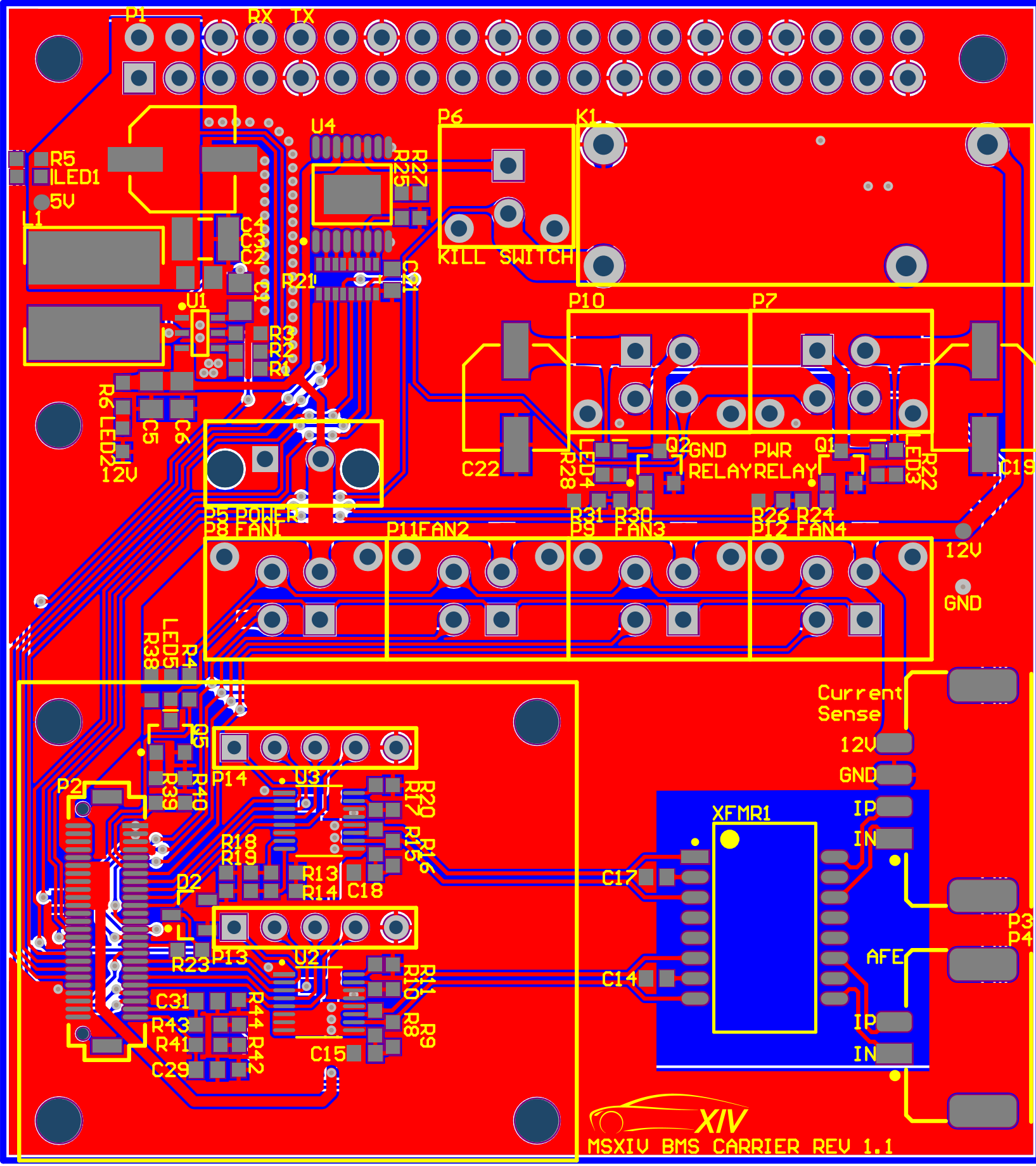


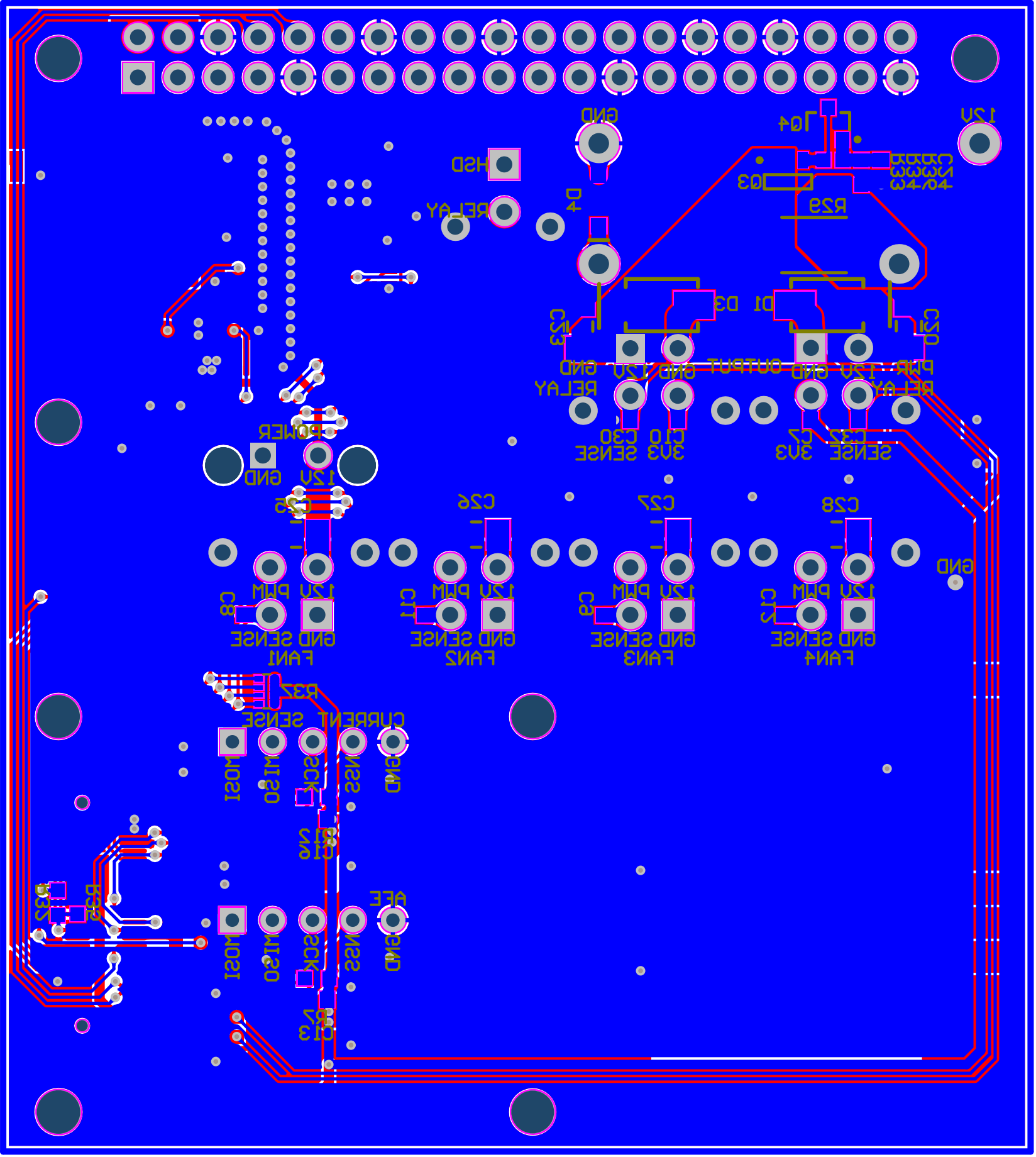
PROJECT BMS_Carrier_Board.PrjPcb		
DOCUMENT BMS Fan and Relay Control		
PART NUMBER MS-ELE0003	VARIANT BMS_Carrier_Board	
DRAWN BY Liam Hawkins	REVISION 1.1	
LAST MODIFIED 2020/11/28		Engineering 5 - 1002 University of Waterloo (519) 888-4567 x32978 hardware@uwmidsun.com

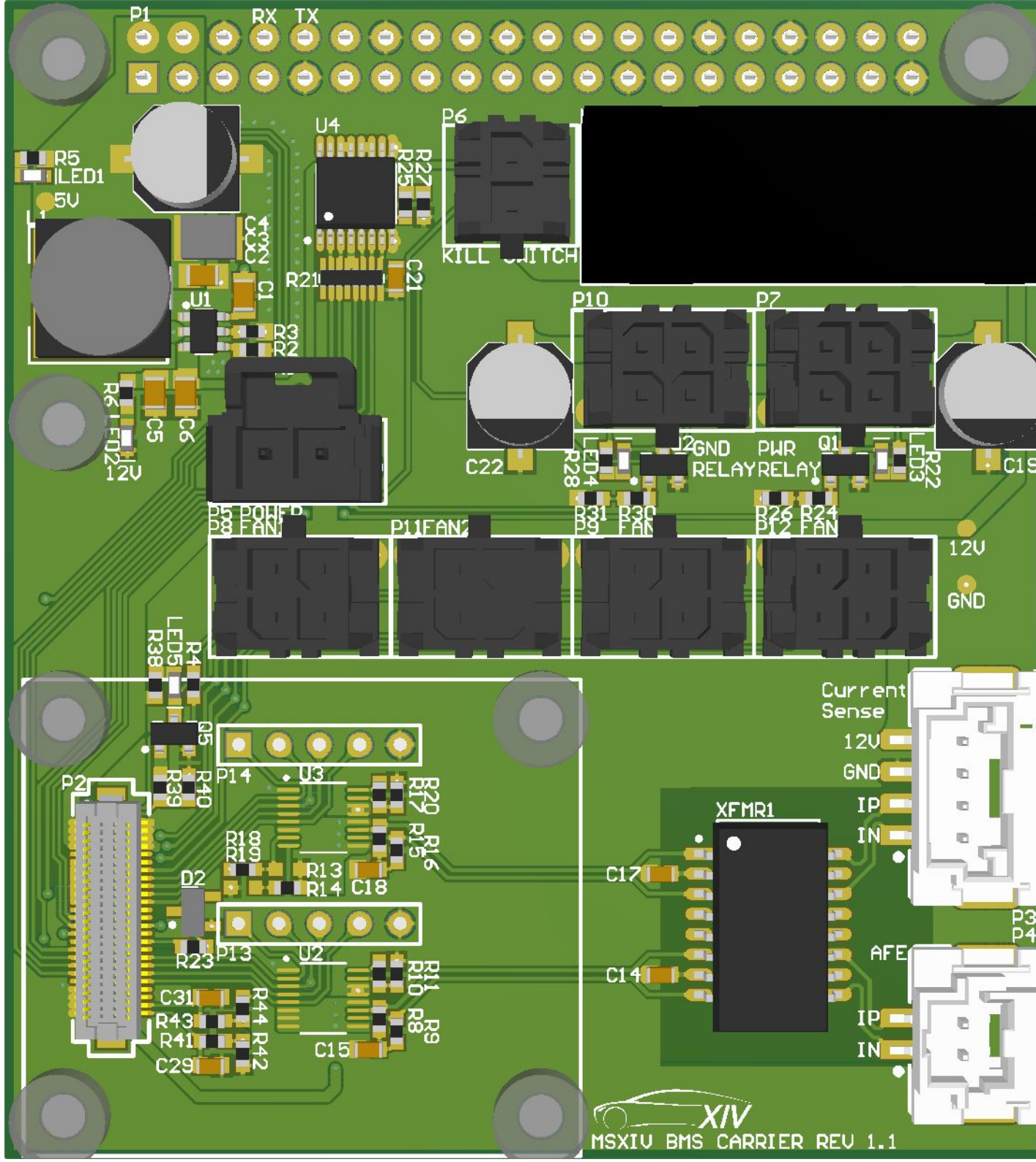
Firmware Detection State of Contactor



PROJECT		BMS_Carrier_Board.PrjPcb		<div><div>MIDNIGHT</div><div></div><div>SUN</div></div> <div>Engineering 5 - 1002 University of Waterloo (519) 888-4567 x32978 hardware@uwmidsun.com</div>					
DOCUMENT						Firmware Detection State of Contactor			
PART NUMBER		MS-ELE0003				VARIANT		BMS_Carrier_Board	
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Electrical Rules Check Report

Class	Document	Message
Error	BMS Carrier - Battery Relay Controls.SchDoc	Duplicate Component Designators LED4
Error	BMS Carrier - Battery Relay Controls.SchDoc	Duplicate Component Designators R35
Error	BMS Carrier - Battery Relay Controls.SchDoc	Duplicate Component Designators R36
Error	BMS Carrier - Battery Relay Controls.SchDoc	Duplicate Net Names Wire NetLED4_1
Warning	BMS Carrier - Connectors.SchDoc	Net PA8 has no driving source (Pin C12-1, Pin P2-7, Pin P12-2, Pin R35-5)
Warning	BMS Carrier - Connectors.SchDoc	Net PB2 has no driving source (Pin C8-1, Pin P2-15, Pin P8-2, Pin R35-8)
Warning	BMS Carrier - Connectors.SchDoc	Net PB10/USART3_TX/I2C2_SCL has no driving source (Pin C11-1, Pin P2-14, Pin P11-2, Pin R35-7)
Warning	BMS Carrier - Connectors.SchDoc	Net PB11/USART3_RX/I2C2_SDA has no driving source (Pin C9-1, Pin P2-13, Pin P9-2, Pin R35-6)

Design Rules Verification Report

Filename : C:\Users\YCA42\hardware\MSXIV_BMS_Carrier_Board\BMS_Carrier_Board.Pc

Warnings 0
Rule Violations 159

Warnings	
Total	0

Rule Violations	
Clearance Constraint (Gap=0.152mm) (All),(All)	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=0.203mm) (Max=2.54mm) (Preferred=0.203mm) (All)	0
Power Plane Connect Rule(Direct Connect)(Expansion=0.508mm) (Conductor Width=0.254mm) (Air Gap=0.254mm)	0
Hole Size Constraint (Min=0.025mm) (Max=5.08mm) (All)	0
Hole To Hole Clearance (Gap=0.254mm) (All),(All)	0
Minimum Solder Mask Sliver (Gap=0.254mm) (All),(All)	159
Silk To Solder Mask (Clearance=0.254mm) (Disabled)(IsPad),(All)	0
Silk to Silk (Clearance=0.254mm) (Disabled)(All),(All)	0
Net Antennae (Tolerance=0mm) (All)	0
Height Constraint (Min=0mm) (Max=25.4mm) (Preferred=12.7mm) (All)	0
Total	159

Minimum Solder Mask Sliver (Gap=0.254mm) (All),(All)

Minimum Solder Mask Sliver Constraint: (0.172mm < 0.254mm) Between Pad C1-1(13.875mm,53.275mm) on Top Layer And Pad R3-1(13.6mm,51.9mm)
Minimum Solder Mask Sliver Constraint: (0.172mm < 0.254mm) Between Pad C1-1(13.875mm,53.275mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.072mm < 0.254mm) Between Pad C1-1(13.875mm,53.275mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.021mm < 0.254mm) Between Pad C11-1(25.676mm,33.916mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.222mm < 0.254mm) Between Pad C1-2(13.875mm,55.025mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.097mm < 0.254mm) Between Pad C12-1(48.401mm,33.9mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.222mm < 0.254mm) Between Pad C13-1(19.5mm,9.6mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.222mm < 0.254mm) Between Pad C13-2(18.15mm,9.6mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.027mm < 0.254mm) Between Pad C15-1(22.357mm,6.725mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.039mm < 0.254mm) Between Pad C15-1(22.357mm,6.725mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.077mm < 0.254mm) Between Pad C18-1(22.364mm,18.05mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.039mm < 0.254mm) Between Pad C18-1(22.364mm,18.05mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.147mm < 0.254mm) Between Pad C2-1(10.425mm,55.4mm) on Top Layer And Pad C3-1(10.225mm,57.8mm)
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad C21-1(23.405mm,55.899mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad C21-2(23.405mm,54.549mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.147mm < 0.254mm) Between Pad C2-2(12.175mm,55.4mm) on Top Layer And Pad C3-2(13.125mm,57.8mm)
Minimum Solder Mask Sliver Constraint: (0.158mm < 0.254mm) Between Pad C24-1(54.55mm,62.665mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.158mm < 0.254mm) Between Pad C24-2(54.55mm,61.315mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C25-1(18.901mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C25-2(16.151mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C26-1(30.301mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C26-2(27.551mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C27-1(41.701mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C27-2(38.951mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C28-1(53.101mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.071mm < 0.254mm) Between Pad C28-2(50.351mm,39mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.045mm < 0.254mm) Between Pad C30-1(38.651mm,46.238mm) on Bottom Layer And Via
Minimum Solder Mask Sliver Constraint: (0.095mm < 0.254mm) Between Pad C30-2(37.301mm,46.238mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.125mm < 0.254mm) Between Pad C7-2(48.751mm,46.237mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.035mm < 0.254mm) Between Pad C8-1(14.263mm,33.933mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.097mm < 0.254mm) Between Pad C9-1(37.001mm,33.9mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.128mm < 0.254mm) Between Pad D2-2(11.825mm,16.35mm) on Top Layer And Via (13.01mm,16.9mm) from
Minimum Solder Mask Sliver Constraint: (0.127mm < 0.254mm) Between Pad D2-3(11.825mm,14.45mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.137mm < 0.254mm) Between Pad D4-1(36.678mm,61.69mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.125mm < 0.254mm) Between Pad K1-2(55.678mm,56.11mm) on Multi-Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.062mm < 0.254mm) Between Pad LED1-1(-0.136mm,61.71mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.062mm < 0.254mm) Between Pad LED1-2(1.364mm,61.71mm) on Top Layer And Pad R5-1(1.4mm,62.8mm)
Minimum Solder Mask Sliver Constraint: (0.095mm < 0.254mm) Between Pad LED3-1(53.9mm,43mm) on Top Layer And Pad R22-2(55.023mm,43mm)
Minimum Solder Mask Sliver Constraint: (0.095mm < 0.254mm) Between Pad LED3-2(53.9mm,44.5mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.069mm < 0.254mm) Between Pad LED4-1(37.7mm,43mm) on Top Layer And Pad R28-2(36.603mm,43mm)
Minimum Solder Mask Sliver Constraint: (0.069mm < 0.254mm) Between Pad LED4-2(37.7mm,44.5mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.183mm < 0.254mm) Between Pad LED5-1(9.51mm,30.416mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.162mm < 0.254mm) Between Pad LED5-1(9.51mm,30.416mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.183mm < 0.254mm) Between Pad LED5-2(9.51mm,28.916mm) on Top Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.162mm < 0.254mm) Between Pad LED5-2(9.51mm,28.916mm) on Top Layer And Pad R4-2(10.7mm,28.9mm)
Minimum Solder Mask Sliver Constraint: (0.105mm < 0.254mm) Between Pad P2-(4mm,22.05mm) on Multi-Layer And Pad P2-(5.5mm,22.8mm) on Top
Minimum Solder Mask Sliver Constraint: (0.105mm < 0.254mm) Between Pad P2-(4mm,7.95mm) on Multi-Layer And Pad P2-(5.5mm,7.2mm) on Top
Minimum Solder Mask Sliver Constraint: (0.247mm < 0.254mm) Between Pad P2-4(7.3mm,19.5mm) on Top Layer And Via (7.3mm,20.4mm) from Top
Minimum Solder Mask Sliver Constraint: (0.022mm < 0.254mm) Between Pad Q1-1(50.7mm,42.5mm) on Top Layer And Pad R24-2(50.7mm,41.4mm) on
Minimum Solder Mask Sliver Constraint: (0.022mm < 0.254mm) Between Pad Q2-1(39.3mm,42.5mm) on Top Layer And Pad R30-2(39.3mm,41.4mm) on
Minimum Solder Mask Sliver Constraint: (0.198mm < 0.254mm) Between Pad Q3-1(47.7mm,62.665mm) on Bottom Layer And Pad
Minimum Solder Mask Sliver Constraint: (0.198mm < 0.254mm) Between Pad Q3-2(48.65mm,62.665mm) on Bottom Layer And Pad

Minimum Solder Mask Sliver (Gap=0.254mm) (All),(All)	
Minimum Solder Mask Sliver Constraint: (0.187mm < 0.254mm) Between Pad R21-13(20.351mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad R21-13(20.351mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.244mm < 0.254mm) Between Pad R21-14(19.843mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad R21-14(19.843mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad R21-15(19.335mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad R21-16(18.827mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.194mm < 0.254mm) Between Pad R21-16(18.827mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.216mm < 0.254mm) Between Pad R21-9(22.383mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.166mm < 0.254mm) Between Pad R21-9(22.383mm,56.2mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.102mm < 0.254mm) Between Pad R2-2(15.15mm,50.745mm) on Top Layer And Pad R3-2(15.15mm,51.9mm)	
Minimum Solder Mask Sliver Constraint: (0.227mm < 0.254mm) Between Pad R2-2(15.15mm,50.745mm) on Top Layer And Via (15.15mm,51.9mm) from	
Minimum Solder Mask Sliver Constraint: (0.147mm < 0.254mm) Between Pad R24-1(49.15mm,41.4mm) on Top Layer And Pad R26-1(47.95mm,41.4mm)	
Minimum Solder Mask Sliver Constraint: (0.082mm < 0.254mm) Between Pad R25-1(24.004mm,59.125mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.235mm < 0.254mm) Between Pad R25-1(24.004mm,59.125mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.207mm < 0.254mm) Between Pad R25-1(24.004mm,59.125mm) on Top Layer And Via (25.14mm,59.125mm)	
Minimum Solder Mask Sliver Constraint: (0.082mm < 0.254mm) Between Pad R25-2(24.004mm,60.675mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.163mm < 0.254mm) Between Pad R3-1(13.6mm,51.9mm) on Top Layer And Pad U1-4(12.475mm,50.95mm)	
Minimum Solder Mask Sliver Constraint: (0.072mm < 0.254mm) Between Pad R3-1(13.6mm,51.9mm) on Top Layer And Pad U1-5(12.475mm,51.9mm)	
Minimum Solder Mask Sliver Constraint: (0.163mm < 0.254mm) Between Pad R3-1(13.6mm,51.9mm) on Top Layer And Pad U1-6(12.475mm,52.85mm)	
Minimum Solder Mask Sliver Constraint: (0.202mm < 0.254mm) Between Pad R32-1(2.445mm,16.5mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.202mm < 0.254mm) Between Pad R32-2(2.445mm,14.95mm) on Bottom Layer And Pad R35-1(3.7mm,15mm)	
Minimum Solder Mask Sliver Constraint: (0.147mm < 0.254mm) Between Pad R33-1(50.9mm,62.665mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.147mm < 0.254mm) Between Pad R33-2(50.9mm,61.115mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.136mm < 0.254mm) Between Pad R34-1(52.1mm,61.115mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.136mm < 0.254mm) Between Pad R34-2(52.1mm,62.665mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad R37-1(16.175mm,29.889mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad R37-2(16.175mm,29.339mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad R37-3(16.175mm,28.839mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad R37-5(15.175mm,28.289mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad R37-6(15.175mm,28.839mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad R37-7(15.175mm,29.339mm) on Bottom Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.206mm < 0.254mm) Between Pad R41-1(11.1mm,7.241mm) on Top Layer And Pad R43-1(11.1mm,8.5mm)	
Minimum Solder Mask Sliver Constraint: (0.072mm < 0.254mm) Between Pad R41-2(12.65mm,7.241mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.206mm < 0.254mm) Between Pad R41-2(12.65mm,7.241mm) on Top Layer And Pad R43-2(12.65mm,8.5mm)	
Minimum Solder Mask Sliver Constraint: (0.218mm < 0.254mm) Between Pad R41-2(12.65mm,7.241mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.197mm < 0.254mm) Between Pad R41-2(12.65mm,7.241mm) on Top Layer And Via (13.775mm,7.266mm)	
Minimum Solder Mask Sliver Constraint: (0.218mm < 0.254mm) Between Pad R42-1(13.775mm,7.241mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.206mm < 0.254mm) Between Pad R42-1(13.775mm,7.241mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.072mm < 0.254mm) Between Pad R43-2(12.65mm,8.5mm) on Top Layer And Pad R44-1(13.775mm,8.5mm)	
Minimum Solder Mask Sliver Constraint: (0.197mm < 0.254mm) Between Pad R43-2(12.65mm,8.5mm) on Top Layer And Via (13.775mm,8.5mm) from	
Minimum Solder Mask Sliver Constraint: (0.162mm < 0.254mm) Between Pad R5-1(1.4mm,62.8mm) on Top Layer And Via (1.364mm,61.71mm) from Top	
Minimum Solder Mask Sliver Constraint: (0.038mm < 0.254mm) Between Pad R8-1(22.357mm,9.405mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.203mm < 0.254mm) Between Pad R8-1(22.357mm,9.405mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.131mm < 0.254mm) Between Pad R8-1(22.357mm,9.405mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.131mm < 0.254mm) Between Pad R8-1(22.357mm,9.405mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.23mm < 0.254mm) Between Pad R8-1(22.357mm,9.405mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.038mm < 0.254mm) Between Pad R8-2(22.357mm,7.855mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.038mm < 0.254mm) Between Pad R8-2(22.357mm,7.855mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.131mm < 0.254mm) Between Pad R8-2(22.357mm,7.855mm) on Top Layer And Pad	
Minimum Solder Mask Sliver Constraint: (0.197mm < 0.254mm) Between Pad U1-5(12.475mm,51.9mm) on Top Layer And Via (13.6mm,51.9mm) from	
Minimum Solder Mask Sliver Constraint: (0.204mm < 0.254mm) Between Pad U2-12(21.007mm,9.675mm) on Top Layer And Via (21mm,10.4mm) from	
Minimum Solder Mask Sliver Constraint: (0.229mm < 0.254mm) Between Pad U3-12(21.014mm,21.05mm) on Top Layer And Via (21mm,21.8mm) from	

Minimum Solder Mask Sliver (Gap=0.254mm) (All),(All)	
Minimum Solder Mask Sliver Constraint: (0.23mm < 0.254mm) Between Pad U3-15(21.014mm,22.551mm) on Top Layer And Via (21mm,21.8mm) from	
Minimum Solder Mask Sliver Constraint: (0.128mm < 0.254mm) Between Pad U4-10(22.525mm,63.55mm) on Top Layer And Via (23.381mm,63.55mm)	
Minimum Solder Mask Sliver Constraint: (0.047mm < 0.254mm) Between Pad U4-7(22.525mm,57.65mm) on Top Layer And Via (23.3mm,57.6mm) from	