

A

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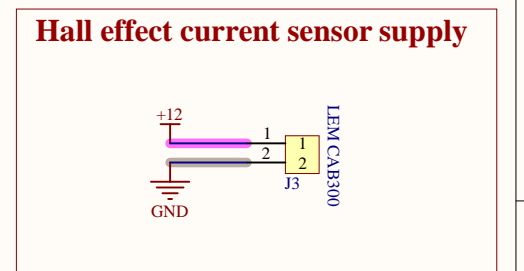
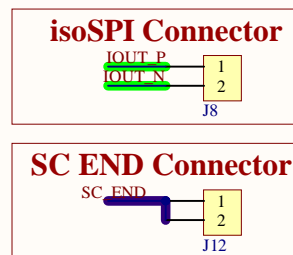
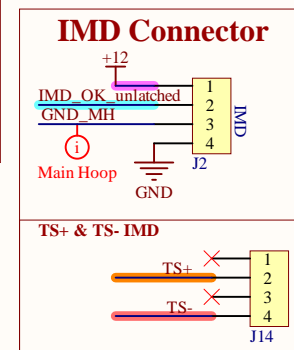
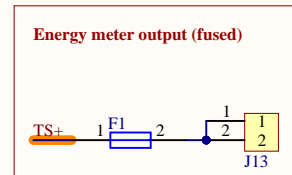
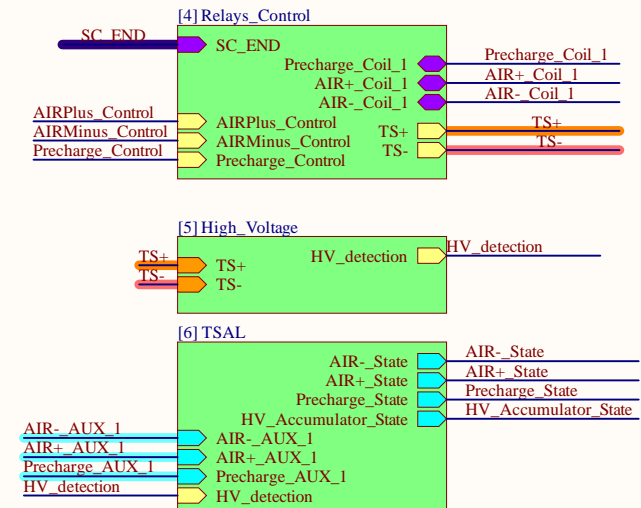
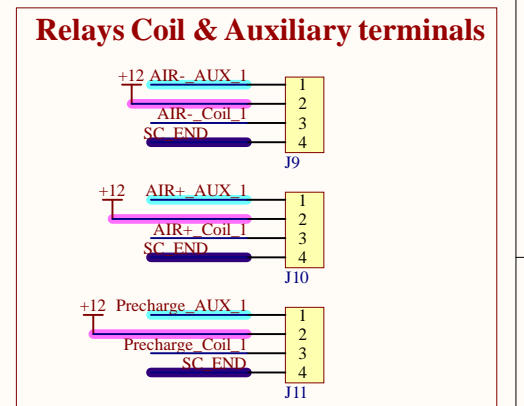
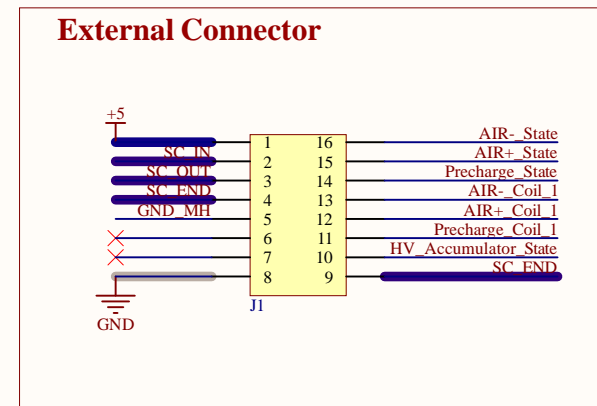
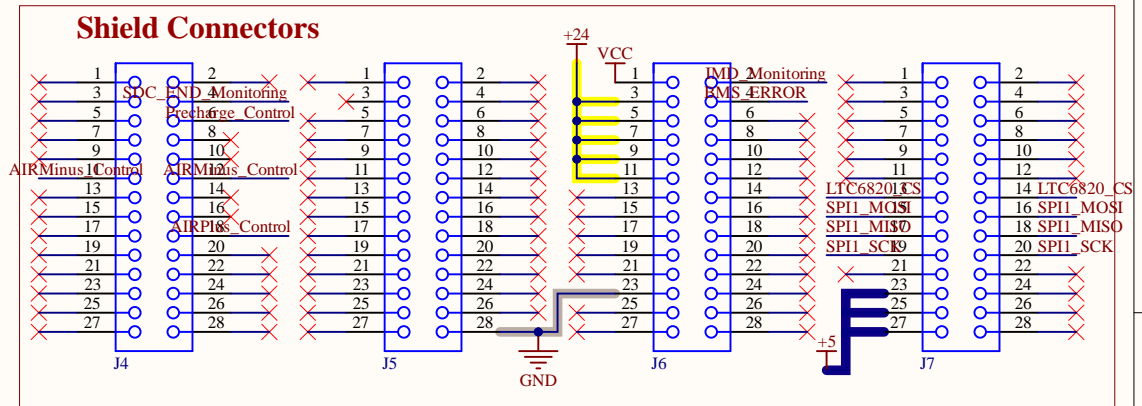
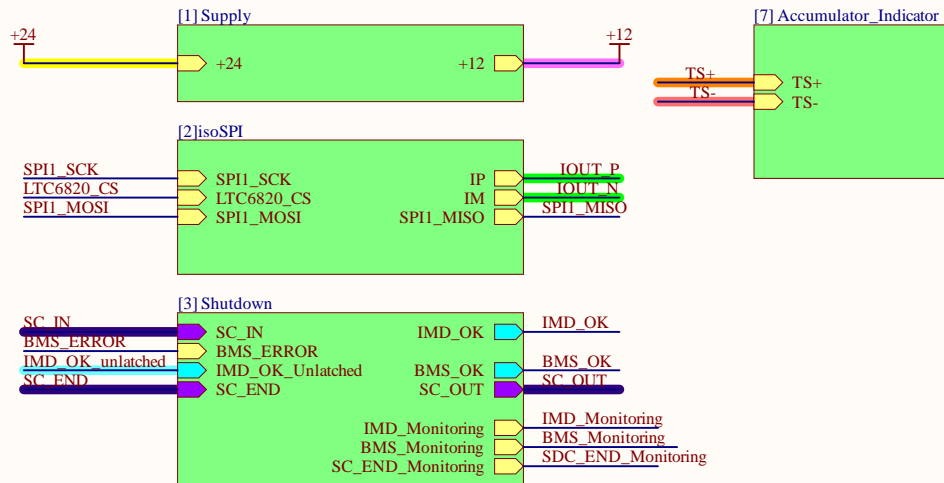
D

A

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D



AMS Master

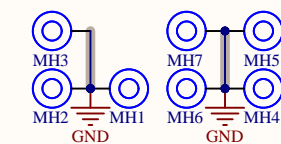
This PCB is the AMS (BMS) Master ECU of the 23-24 Accumulator from e-Tech Racing Formula Student Team.

All the computation is done on the SHIELD board, a PCB with an STM32 microcontroller, two can transceivers and 3.3, 5 and 24 V supply. The connection is done by 4 board to board pin header connectors and most of the microcontroller pins are available. In this case it is used for signal monitoring, SPI communication to the AMS slaves and relay control.

The board, besides communicating to the AMS, monitors 2 logical signals that are sent by CAN and controls 4 relays, one being the AMS SDC node and the other 3 being PRECHARGE, AIR- and AIR+.

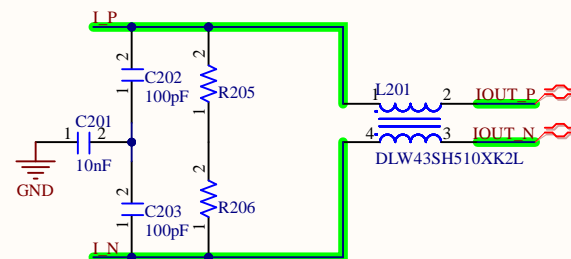
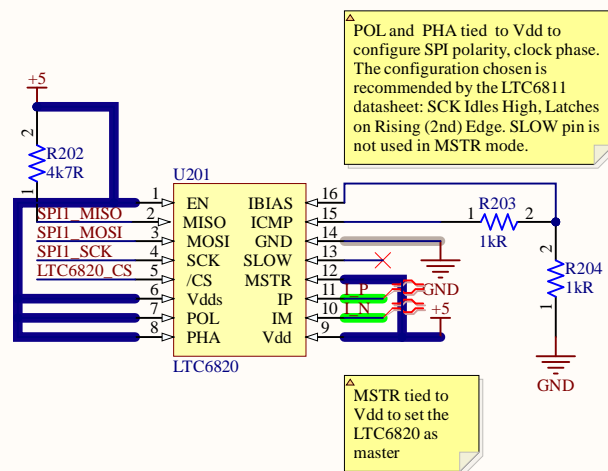
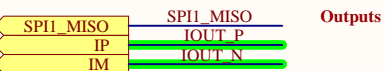
In addition to that, the board provides all the signals needed for the TSAL control and also lights the accumulator indicator LED when there are more than 60V between TS+ and TS-. This year we decided to add a tractive system part on the board, which contains the 3 accumulator controlling relays, to avoid having too much wires in the front part of the accumulator.


Green: isoSPI  
Cyan: External signal  
Orange: High Voltage  
Red: Negative high voltage  
Pink: Supply  
Gray: GND  
Purple: Shutdown chain

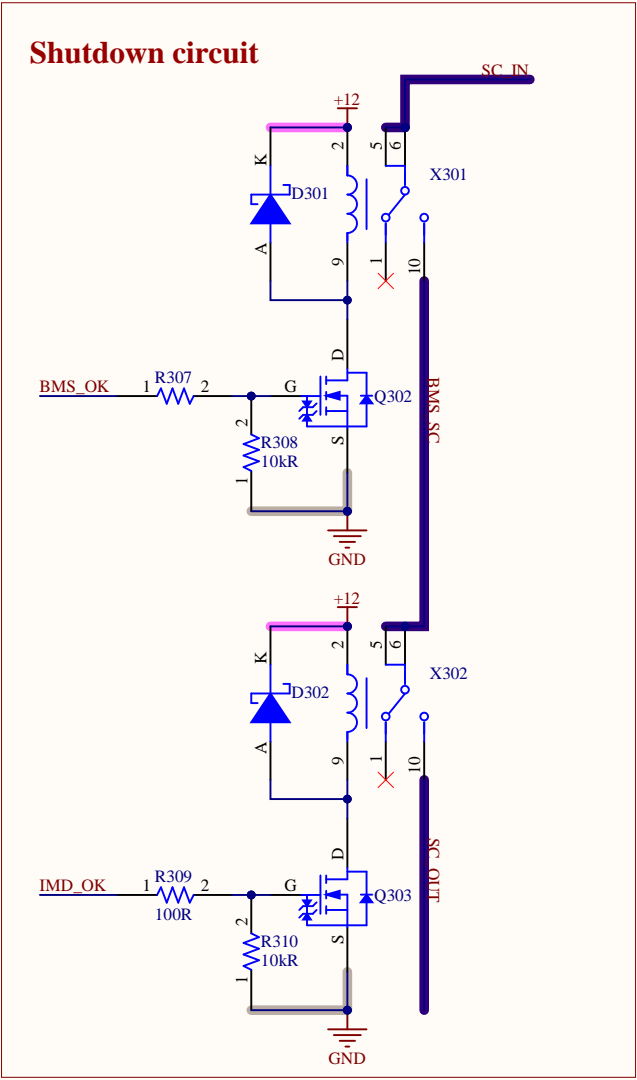
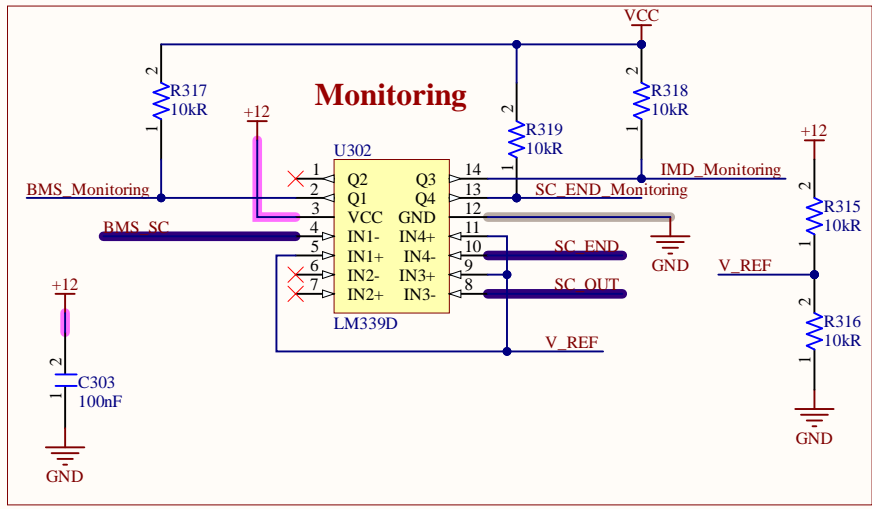
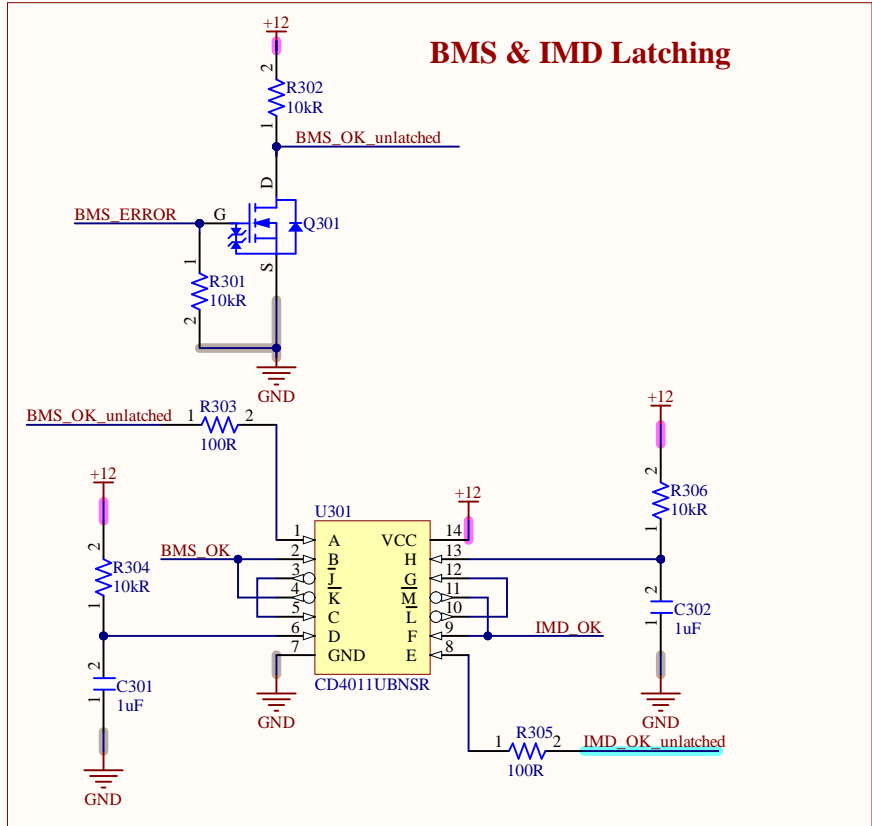


Company:		Variant: [No Variations]	
Project:	AMS_Master.SchDoc		Version:
Size:	-		Department:
Author:		Sheet 1 of 10	
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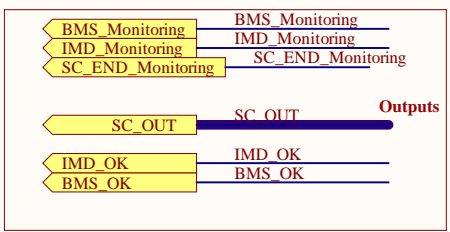
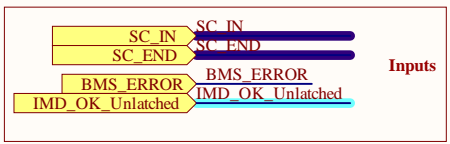


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Project: Variant: [No Variations]		
Size:	Page Contents:	Version:
-	[2]IsoSPI.SchDoc	Department:
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Checked by:		Date: 01/02/2024




Hardware latching in order to comply with EV 6.1.6 achieved with a RS latch implemented with NAND gates ( U301 ).

IMD\_OK\_unlatched comes from IMD (Bender A-ISOMETER® iso-F1 IR155-3204) at +10 V logic signal.



U302 checks if previous component on the Shutdown Chain is closed and outputs a logic signal to the microcontroller on Shield PCB board.

Company:		
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Variant: [No Variations]		
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SC\_End SC\_End  
AIRPlus\_Control AIRPlus\_Control  
AIRMinus\_Control AIRMinus\_Control  
Precharge\_Control Precharge\_Control

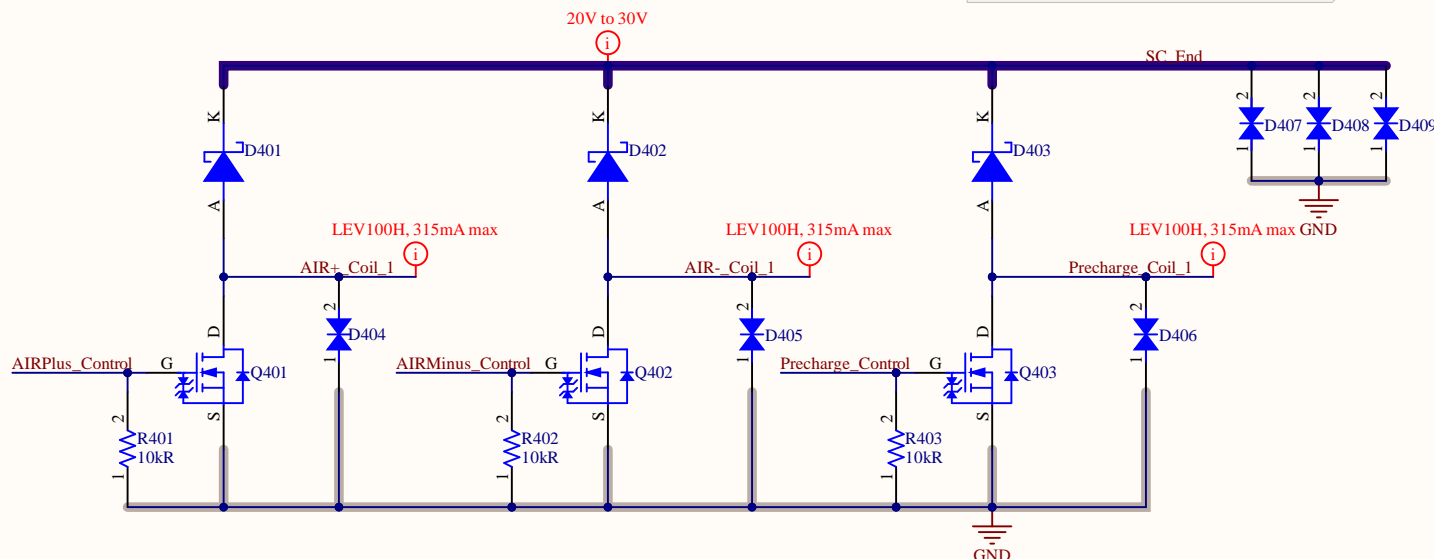
Inputs

Precharge\_Coil\_1 Precharge\_Coil\_1  
AIR+ Coil\_1 AIR+ Coil\_1  
AIR- Coil\_1 AIR- Coil\_1

TS+ TS+  
TS- TS-

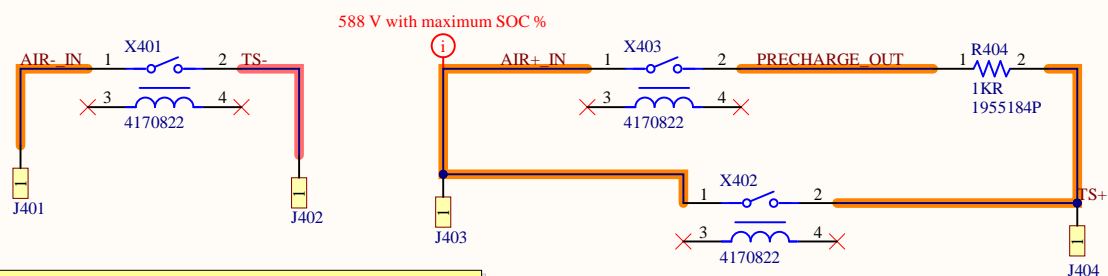
Outputs

## Relays control



Relays' coils are connected to the end of the shutdown chain on one side (Coil 2), so when any of the N-MOS switches, the other coil lead (Coil 1) is connected to GND, and thus current flows through it and the relay is closed.

## AIRs & Precharge



There are 588V between TS+ and TS- , 3,25 mm of spacing between traces is needed. The accumulator peak discharge current is 145 A, to size the traces to withstand this it the used stackup is 35um external and 70 um internal.

The power traces are routed on the 4 layers to be able to use as much copper as possible. The trace width required, assuming 50% of the peak current as nominal, is less than 10 mm , using the same for internal and external layers. Using this width the internal layers can withstand 37 A, while the external ones 43 A. Adding up to more than 72.5 A. Even so , wider traces will be used if possible.

Company:		e-tech	
Project:		Variant: [No Variations]	
Size:	Page Contents:		Version:
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Author:		Sheet 6 of 10	
Checked by:		Date: 01/02/2024	

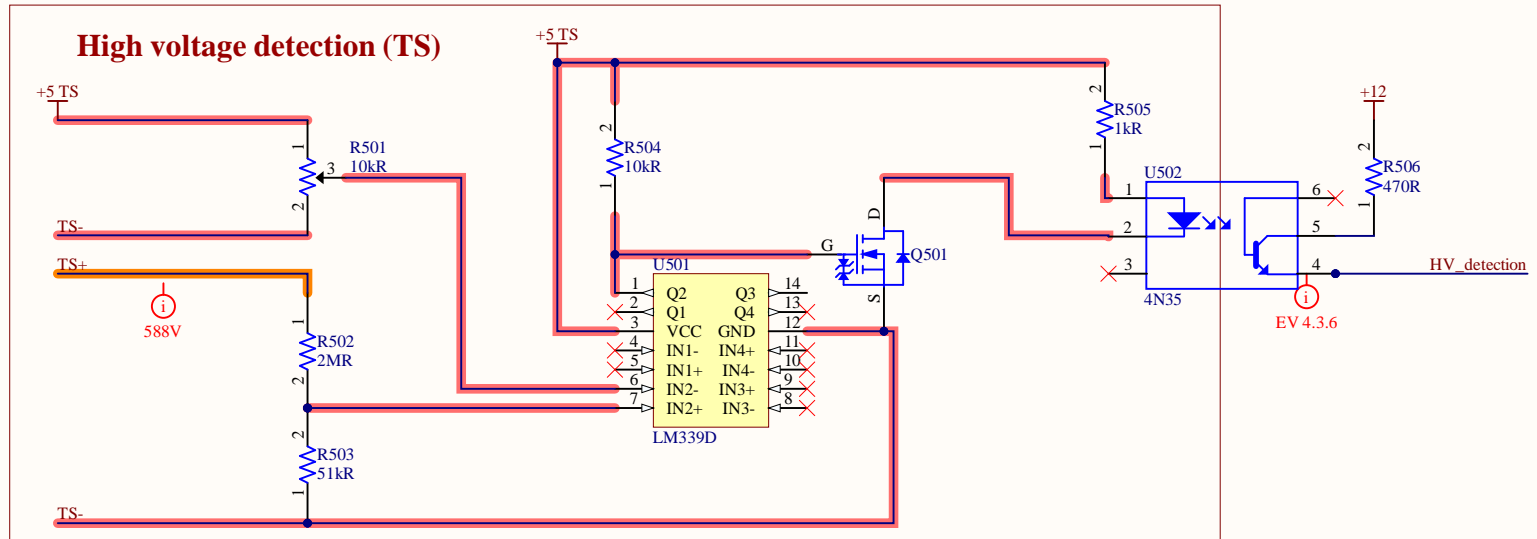
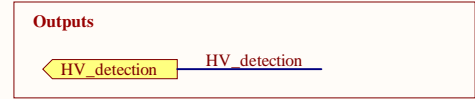
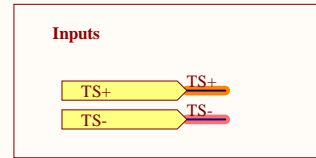
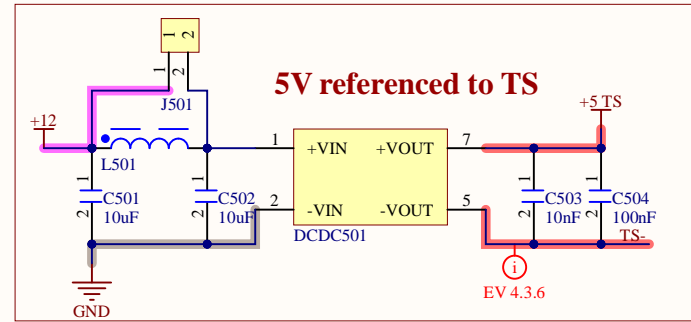
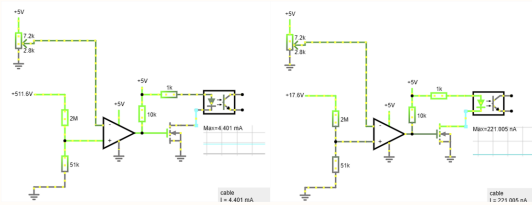
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
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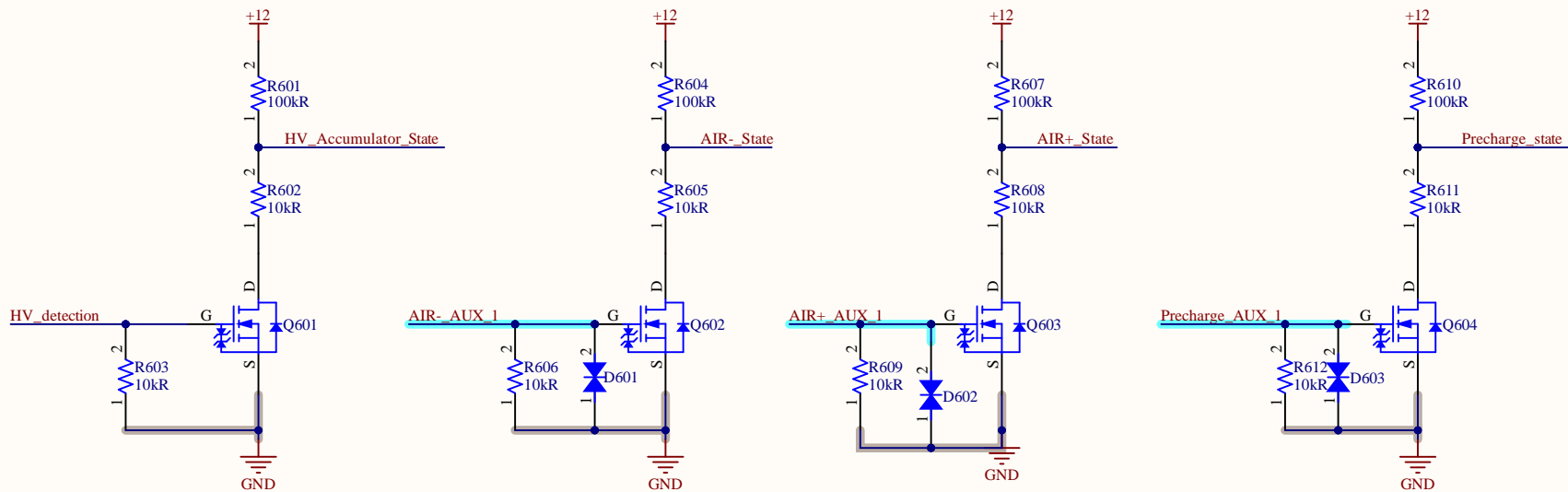
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△ HV detection:  
When TS>60V the LED  
from the optocoupler  
must be lit. To  
accomplish this, a  
comparator is used with a  
voltage divider across TS  
and a trimmer to adjust  
the voltage trigger.



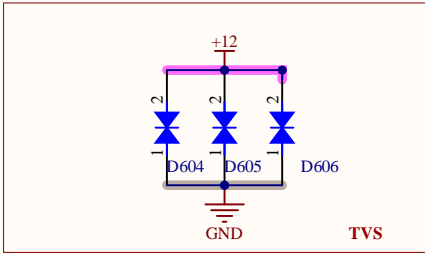
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-	[5] High_Voltage_SchDoc	Department:
Author:		Sheet 8 of 10
Checked by:		Date: 01/02/2024



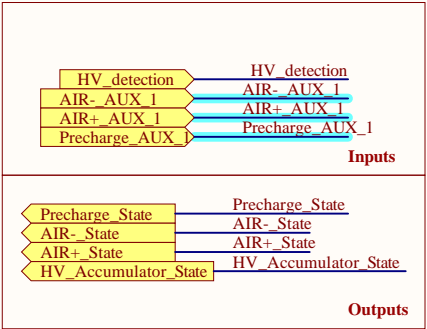
A


All four states are 12V logic. The resistor pull-up/down configuration is designed according to TSAL's expected configuration and be able to detect implausibilities (they are SCS (T 11.9) with exceptions EV 4.10.13 and EV 4.10.14).

TVS Diodes are present due to possible EMI coming from when Shutdown Chain opens, AIRs open and a voltage peak appears.



TVS



Company:			
Project:		Variant: [No Variations]	
Size:	Page Contents:		Version:
-	[6] TSAL.SchDoc		Department:
Author:		Sheet 9 of 10	
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A

A

B

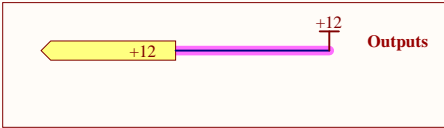
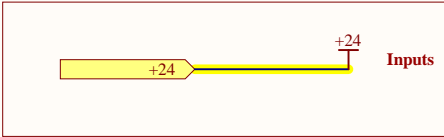
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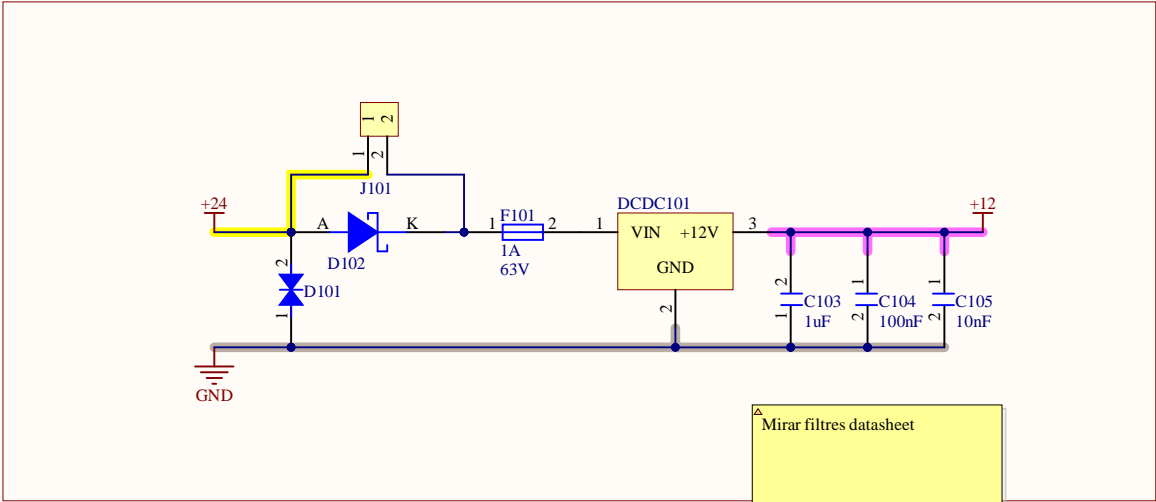
C

D

D



+24 is supplied after an LC pi filter from the Shield.



Mirar filtros datasheet

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Size	Number	Revision
A4		
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File:	C:\Escritorio\...\[1] Supply.SchDoc	Drawn By:

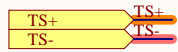
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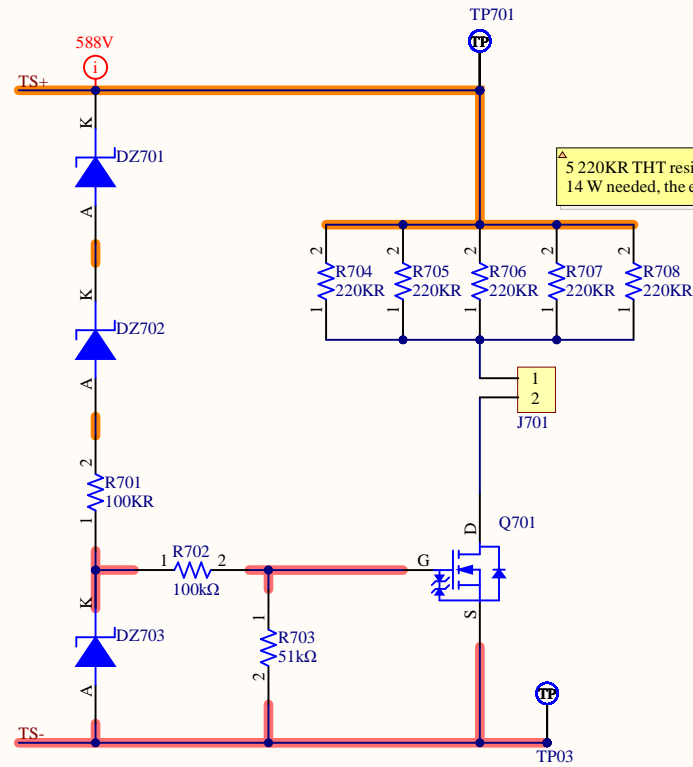
4

## Inputs



<sup>A</sup> The accumulator indicator function is to light the LED in **Not found** when there are more than 60V between TS' and TS-, even if the LV is disconnected.

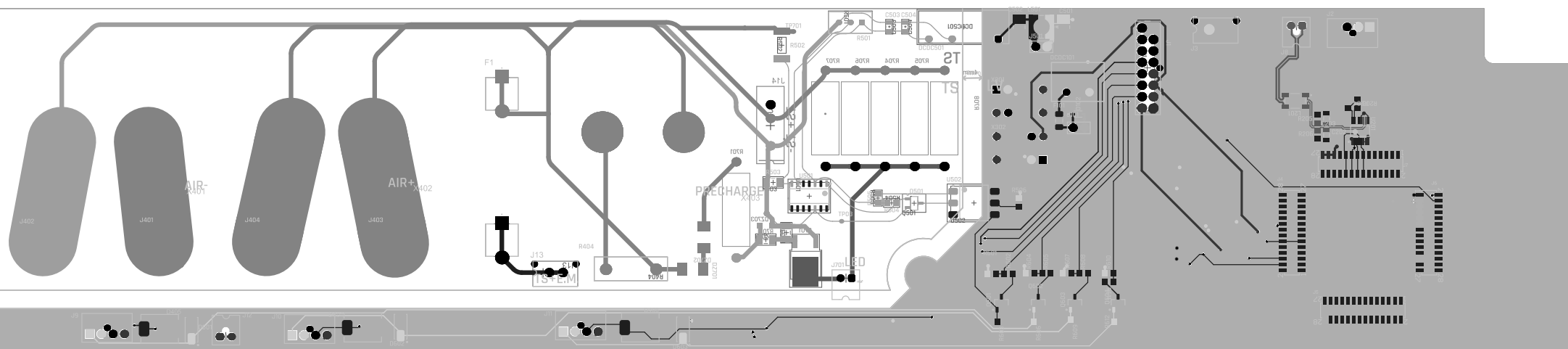
## Accumulator indicator (TS)



<sup>A</sup> 5 220KR THT resistors are used to dissipate the 14 W needed, the equivalent resistance is 44KR

Title		
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A4		
Date:	2/01/2024	Sheet of
File:	C:\Escritorio\...\[7] Accumulator_Indicator.Dwg By:	





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