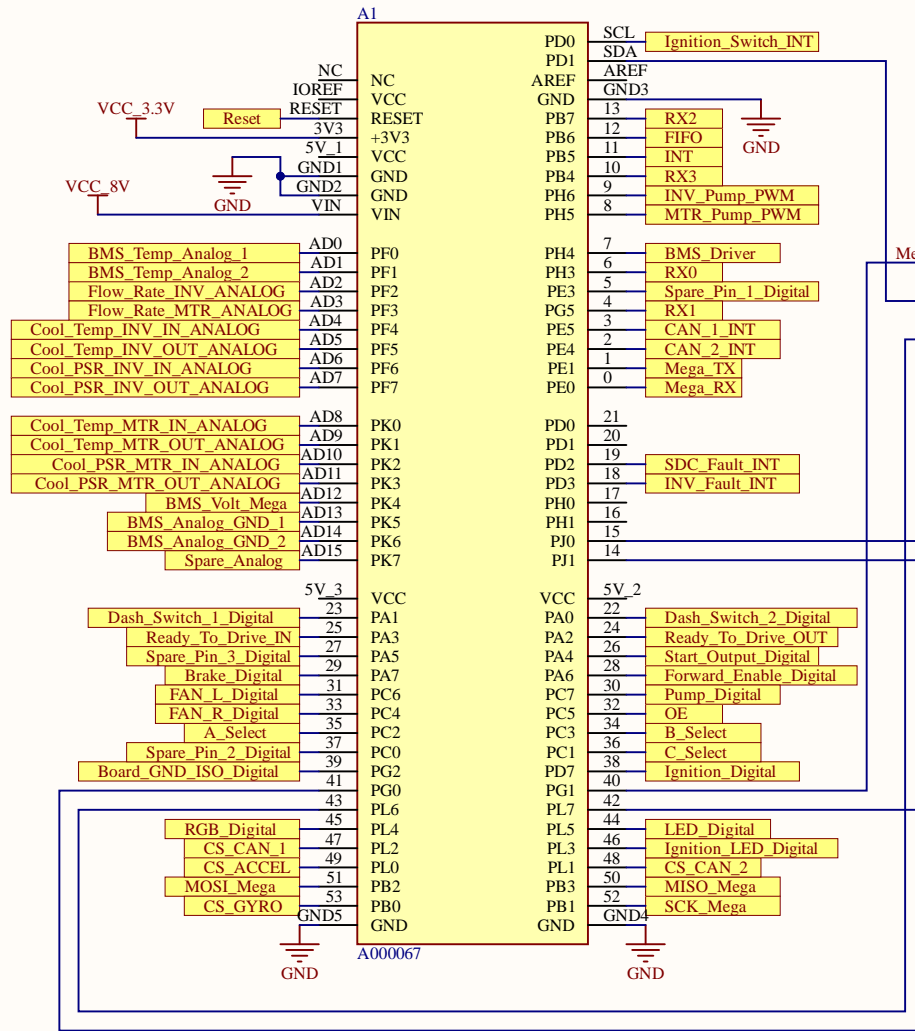
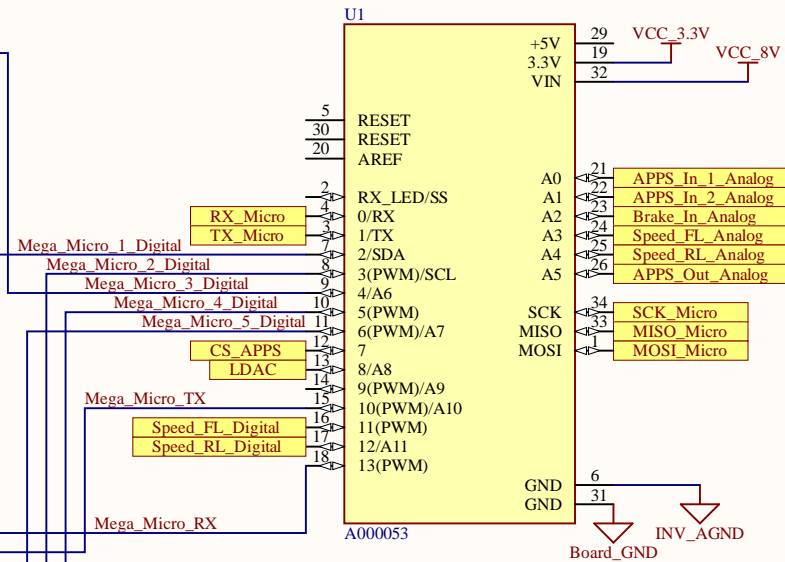


## Arduino Mega Shield



## Arduino Micro Shield



Interrupts: Mega\_Micro\_1\_Digital, Mega\_Micro\_2\_Digital

INV\_AGND will be a trace coming from the powertrain connector to clean up the APPS OUT Signal.

Interrupts: Ignition\_Switch, SDC\_Fault, CAN\_1, CAN\_2, Mega\_Micro\_2\_Digital, Micro\_3\_Digital  
PCINTs: FIFO, INT

Schematic

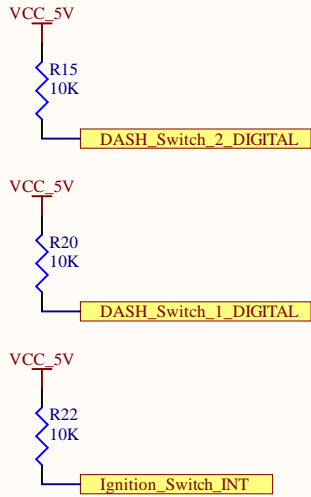
Layout

Calculations

Tall components near mounting points

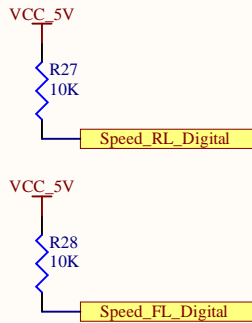
Title <b>Arduino Shields</b>		
Size A4	Number <b>1</b>	Revision <b>v.3.0</b>
Date: 3-26-2022	Sheet of 10	
File: D:\Benjamin\...\Arduino_Shields.SchDoc	Drawn By: Benjamin Liang	

## Switch Pull Up Resistors

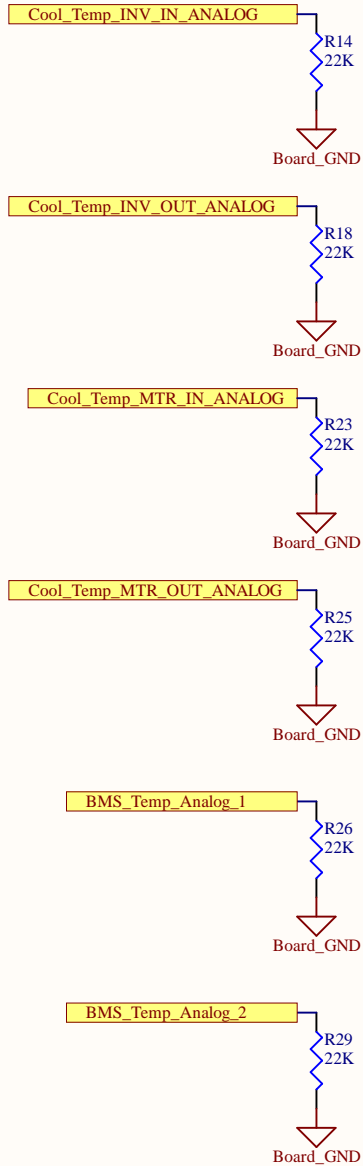


Wheel speed sensor is open collector and switches all switch to ground.

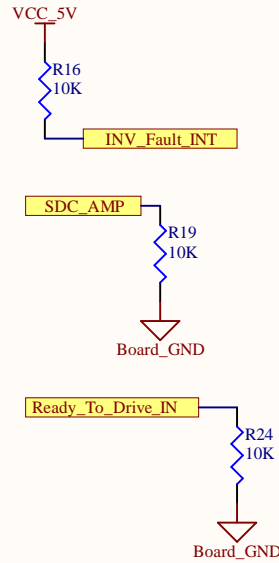
## Hall Effect Pull Up Resistors



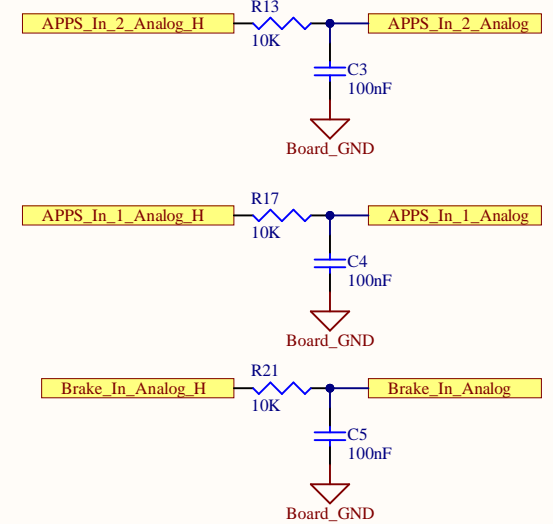
## Thermistor Pull Down Resistors



## System Critical Pull Up/Down



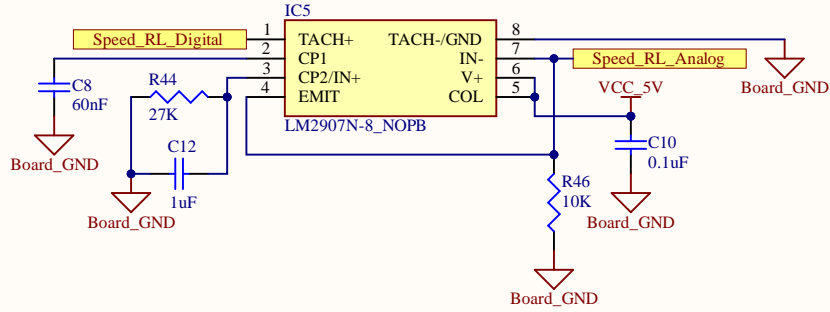
## Drive Signal Filters



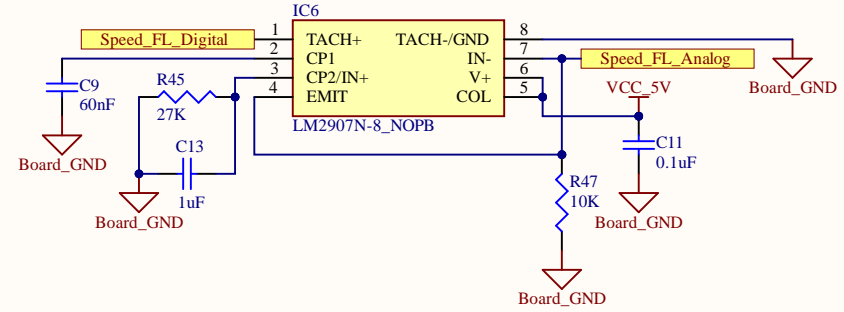
RC filter for drive critical analog inputs, resistor can be substituted with 00hm resistor if not needed

Title <b>Passive Circuits</b>			
Size A4	Number <b>2</b>		Revision <b>v.3.0</b>
Date:	3-26-2022		Sheet of 10
File:	D:\Benjamin\.\Passive_Circuits.SchDoc		Drawn By: Benjamin Liang

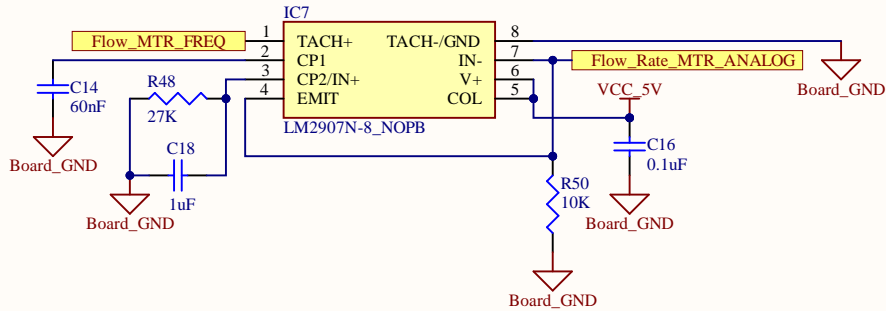
## Wheel Speed RL



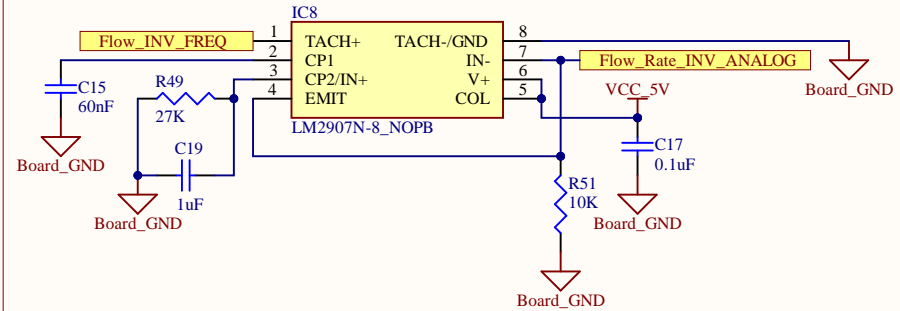
## Wheel Speed FL



## Flowrate MTR



## Flowrate INV



Max frequency is 452Hz with max speed of 130kph, 18" wheels and 18Hz per cycle. 600Hz with FOS which requires a 60nF capacitor.

Title			Frequency to Analog
Size	Number	Revision	
A4	3	v.3.0	
Date:	3-26-2022	Sheet of	10
File:	D:\Benjamin\...\Frequency_Analog.SchDoc Drawn By: Benjamin Liang		

Pin configuration for J3 connector:

Pin	Signal
1	Board_GND
2	CAN1
3	CANL
4	
5	RX1
6	RX0
7	
8	
9	
10	Board_GND
11	VCC_5V
12	Reset
13	CS_CAN_1
14	MISO_Mega
15	MOSI_Mega
16	SCK_Mega
17	CAN_1_INT
18	CAN_1_INT
19	CAN_1_INT
20	CAN_1_INT

Pin configuration diagram for the 5-535541-8\_1 component. The component has 20 pins. Pin 1 is connected to VCC\_3.3V. Pin 11 is connected to VCC\_5V. Pin 10 is connected to Board\_GND. Pins 12-15 are connected to CS\_ACCEL, MISO\_Mega, MOSI\_Mega, and SCK\_Mega respectively. Pin 19 is connected to OE. Pins 2, 3, 4, 5, 6, 7, 8, 9, 16, 17, 18, and 20 are unconnected.

Pin configuration diagram for the STM32F405VGT6 microcontroller. The diagram shows a 48-pin package with pins numbered 1 to 20 on the left and 21 to 48 on the right. Various pins are labeled with their functions: DAQ\_CANH, DAQ\_CANL, RX3, RX2, J6, VCC\_5V, Reset, CS\_CAN\_2, MISO\_Mega, MOSI\_Mega, SCK\_Mega, CAN\_2\_INT, and Board\_GND. The J6 header is connected to pins 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20. The VCC\_5V is connected to pin 11. The Reset is connected to pin 12. The CS\_CAN\_2 is connected to pin 13. The MISO\_Mega is connected to pin 14. The MOSI\_Mega is connected to pin 15. The SCK\_Mega is connected to pin 16. The CAN\_2\_INT is connected to pin 17. The Board\_GND is connected to pin 18.

The diagram shows the pin configuration for the J7 connector. The pins are numbered 1 through 20. The connections are as follows:

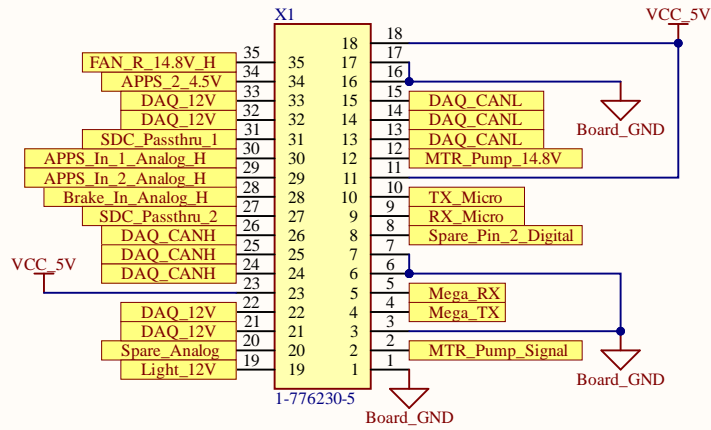
- VCC\_3.3V is connected to pin 1.
- VCC\_5V is connected to pin 11.
- CS\_GYRO is connected to pin 12.
- MISO\_Mega is connected to pin 13.
- MOSI\_Mega is connected to pin 14.
- SCK\_Mega is connected to pin 16.
- FIFO is connected to pin 5.
- INT is connected to pin 6.
- OE is connected to pin 19.
- Board\_GND is connected to pin 10.

The connector is labeled J7 and the board part number is 5-535541-8\_1.

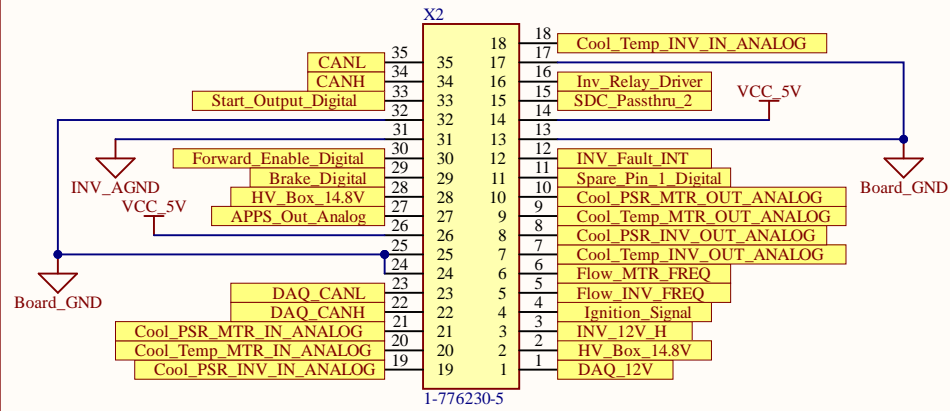
△ CANL and CANH traces should be similar length

Title				SPI Breakout Modules			
Size A4		Number 4			Revision v.3.0		
Date: 3-26-2022					Sheet of 10		
File: D:\Benjamin\...\SPI_Breakout.SchDoc					Drawn By: Benjamin Liang		

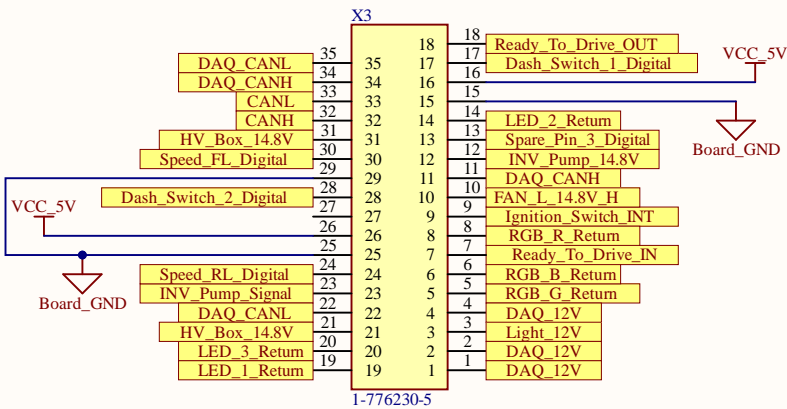
## Right Body Connector



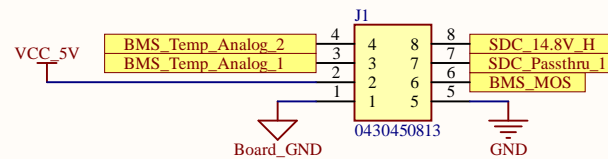
## Powertrain Connector



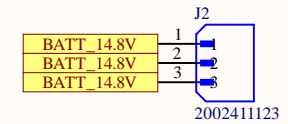
## Left Body Connector



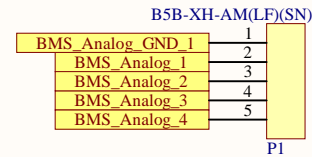
## Internal Connector



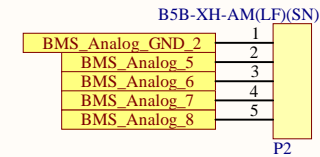
## Battery Connector



## BMS Connector 1



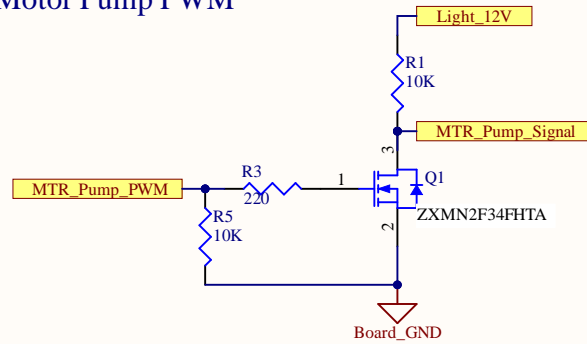
## BMS Connector 2



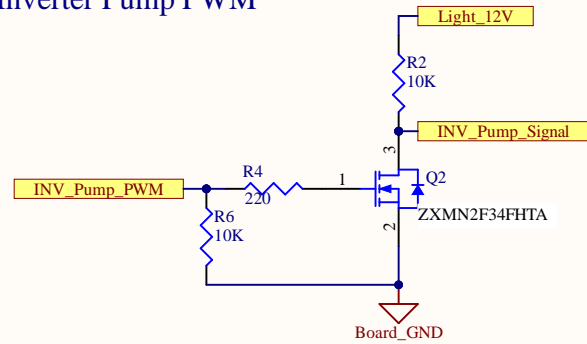
ACM\_GND was on powertrain harness, can use spare ground (Board\_GND) on left body connector if harness want ACM\_GND with the ACM\_14.8V

Title		
Connectors		
Size	Number	Revision
A4	5	v.3.0
Date:	3-26-2022	Sheet of 10
File:	D:\Benjamin\...\Connector.SchDoc	Drawn By: Benjamin Liang

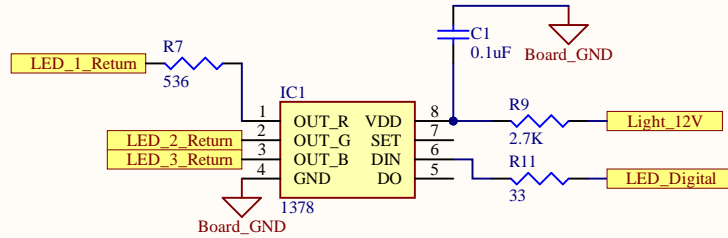
## Motor Pump PWM



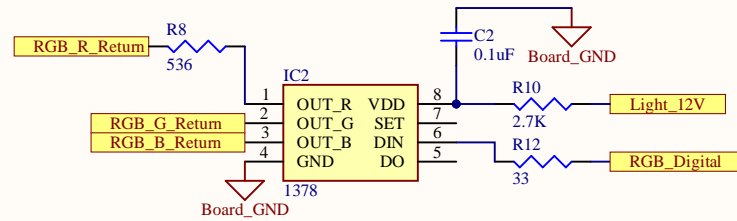
## Inverter Pump PWM



## LED PWM Driver

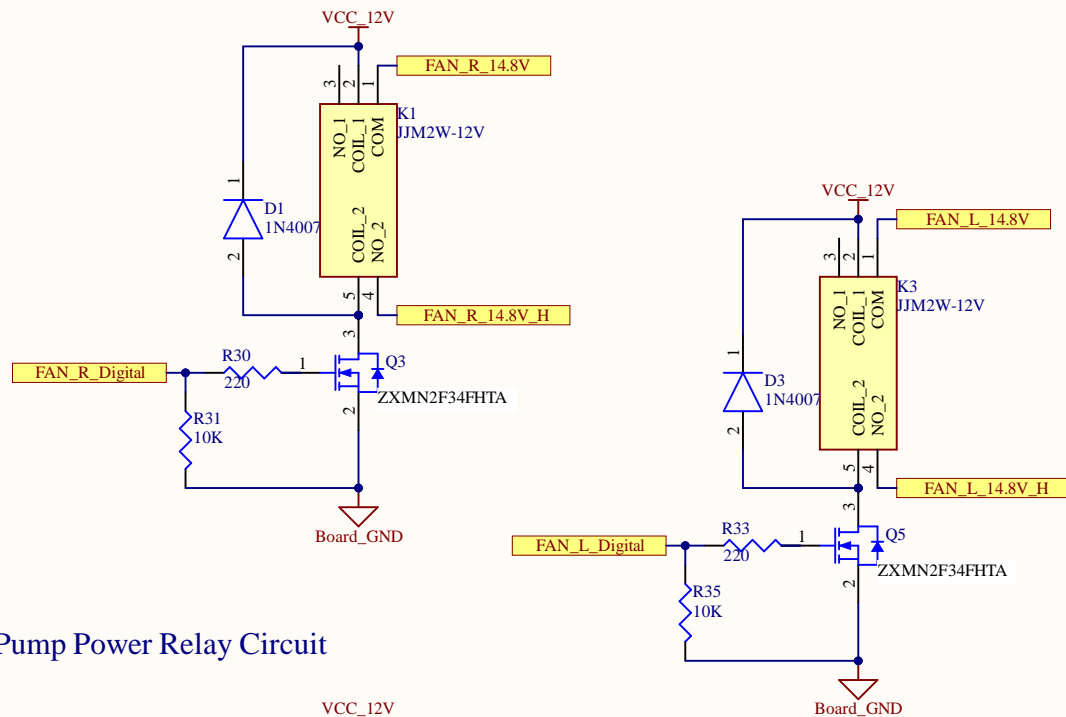


## RGB PWM Driver

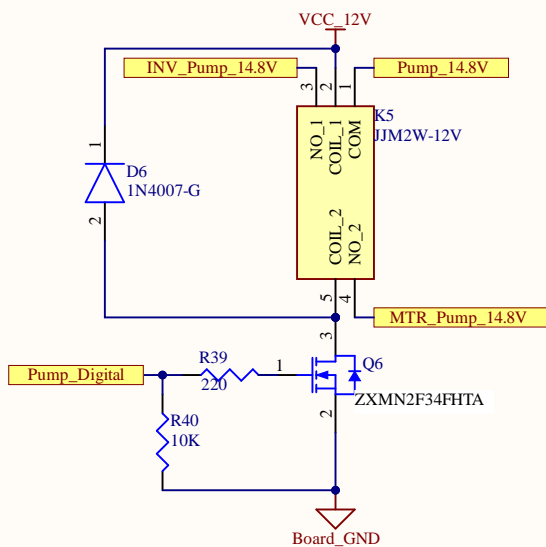


Title Mosfet and PWM			
Size A4	Number 6	Revision v.3.0	
Date: 3-26-2022	Sheet of 10		
File: D:\Benjamin\...\PWM_Pump_Led.SchDoc	Drawn By: Benjamin Liang		

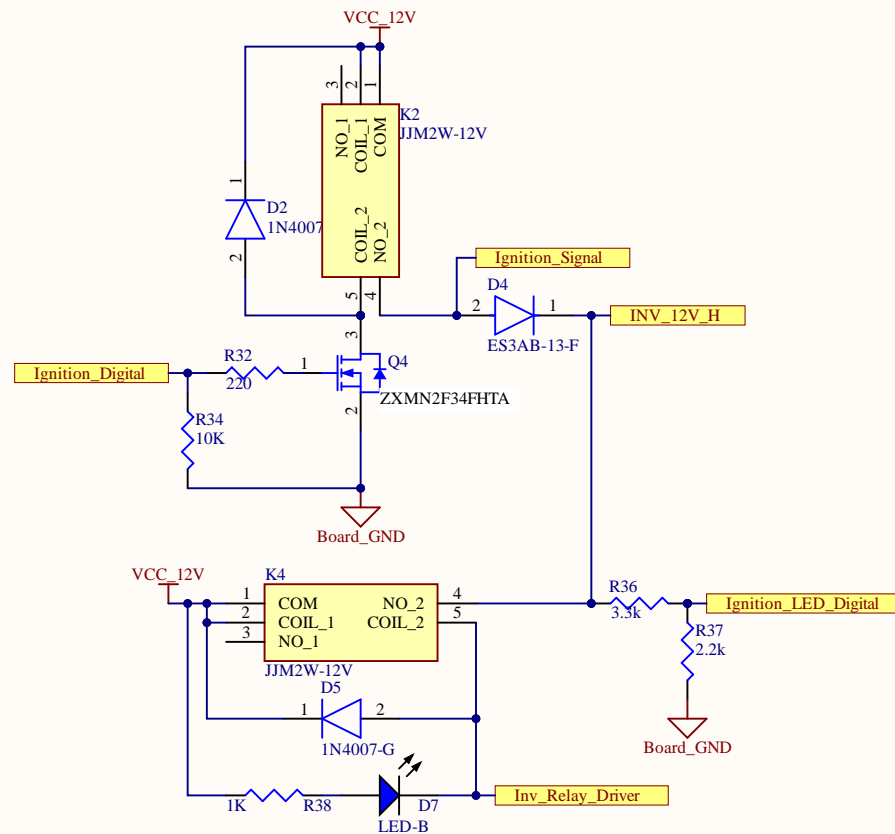
## Rad Fan Power Relay Circuits



## Pump Power Relay Circuit



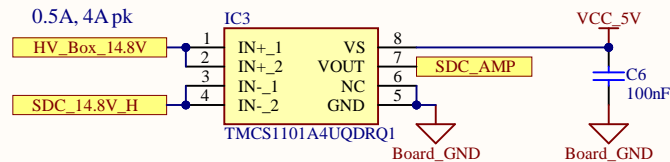
## Inverter Ignition Circuit



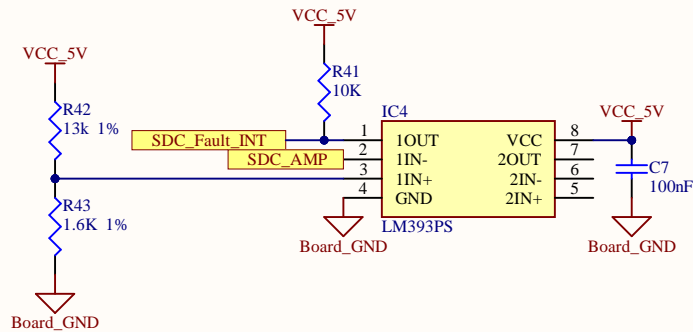
Place Flyback Diodes near coil

Title				Ignition and Multiplexer			
Size		Number			Revision		
A4		7			v.3.0		
Date:		3-26-2022			Sheet of		10
File:		D:\Benjamin\...\Power_Relay.SchDoc			Drawn By:		Benjamin Liang

## 14.8V SDC Pass-Through and Current Sensor



## Shutdown Circuit Current Comparator



Current Sensor: Minimize adjacent high-current traces in close proximity to the device. The input current trace can contribute additional magnetic field to the sensor if the input current traces are routed parallel to the vertical axis of the package. Merge input traces for both IN+ and IN- inputs. make sure to consider the PCB design required creepage and clearance for system-level isolation requirements.

For better sensor thermal performance: Use large copper planes for both input current path and isolated power planes and signals. Use heavier copper PCB construction. Place thermal via farms around the isolated current input.

Comparator: Zero current is 0.5V, with 400mV/A sensitivity. Typical current of SDC is approx. 200mA so short circuit cut off is set at 43.1mA.

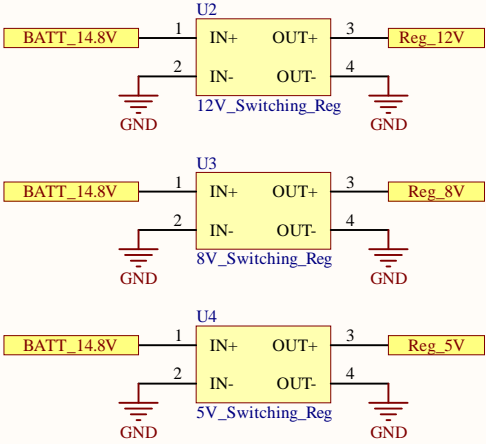
Comparator: Minimize coupling between outputs and inverting inputs to prevent output oscillations. Do not run output and inverting input traces in parallel unless there is a VCC or GND trace between output and inverting input traces to reduce coupling. Why series resistors?

Location of current sensor IC3 can be adjusted to accommodate layout. Other possible locations include SDC pass-throughs 1 and 2.

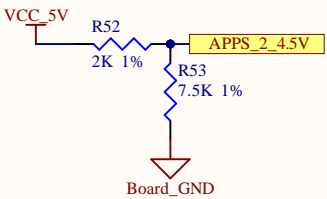
Title			Shutdown Circuit Trip	
Size	Number	8		Revision
A4				v.3.0
Date:	3-26-2022	Sheet of	10	
File:	D:\Benjamin\.\Shutdown_Circuit.SchDoc		Drawn By:	Benjamin Liang



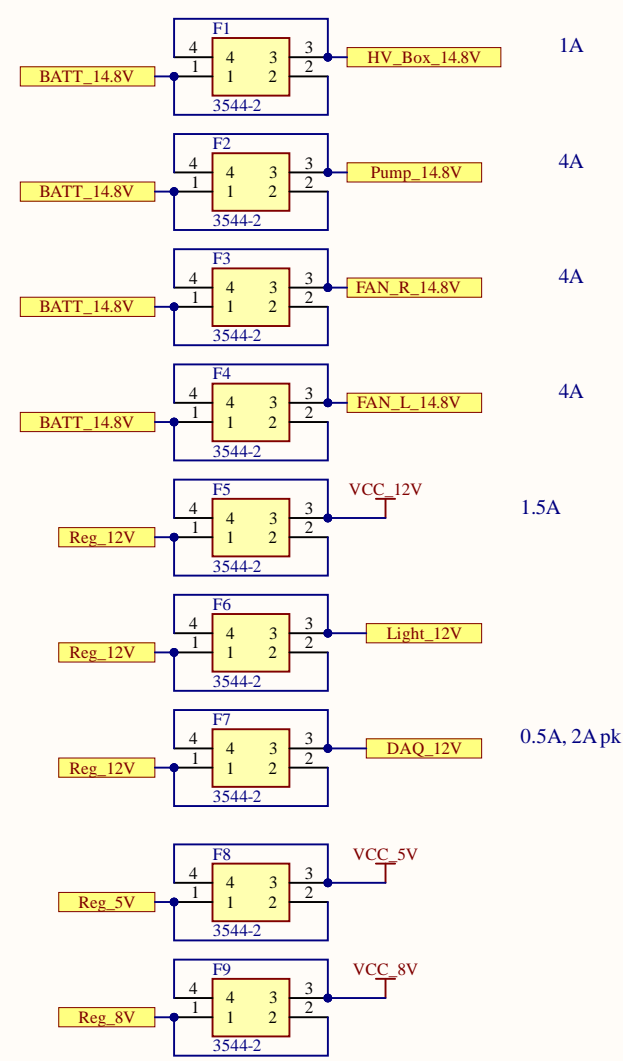
Regulators



APPS Voltage Divider

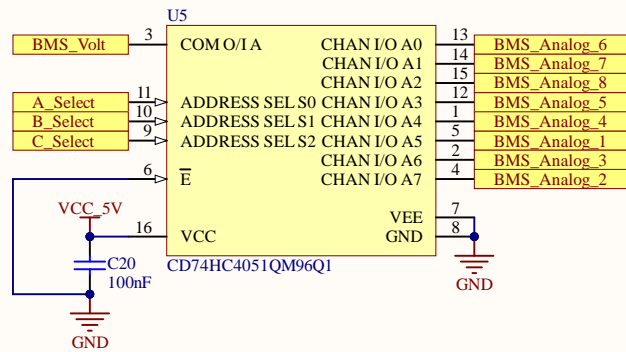


Thermal Fuses

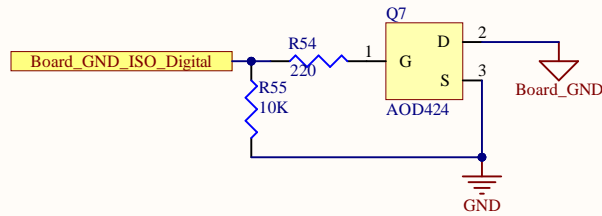


Title Power Distribution			
Size A4	Number 9	Revision V.3.0	
Date:	3-26-2022	Sheet of	10
File:	D:\Benjamin\...\Power_Distribution.SchDocDrawn By: Benjamin Liang		

## BMS Voltage



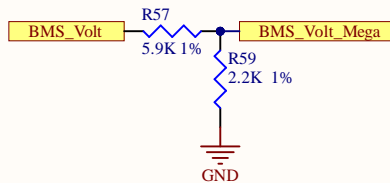
## Board Ground Isolation Mosfet



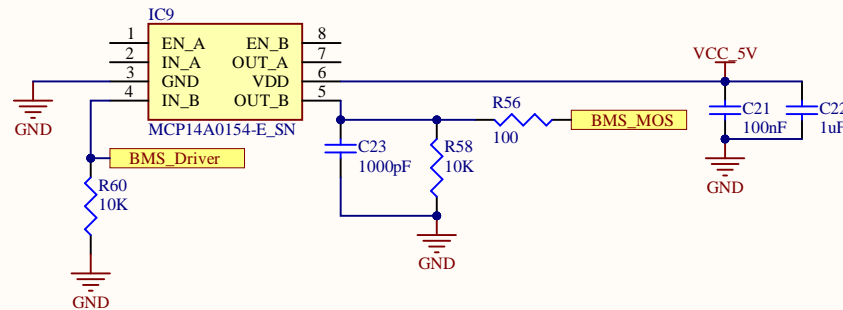
△ The trace loop length and inductance should be minimized by the use of ground planes or traces under the MOSFET gate drive signal. Separate analog and power grounds, and local driver decoupling should also be used. Ground plane under device is recommended.

△ BMS voltage gets divided to a maximum of 4.563V when the battery voltage is 16.8V

## BMS Voltage Divider



## BMS Signal Gate Driver



Title Power Distribution			
Size A4	Number 10	Revision V.3.0	
Date:	3-26-2022	Sheet of	10
File:	D:\Benjamin\...\BMS.SchDoc	Drawn By:	Benjamin Liang



