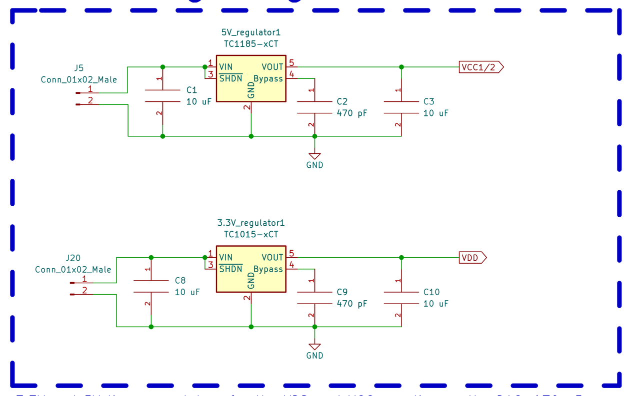
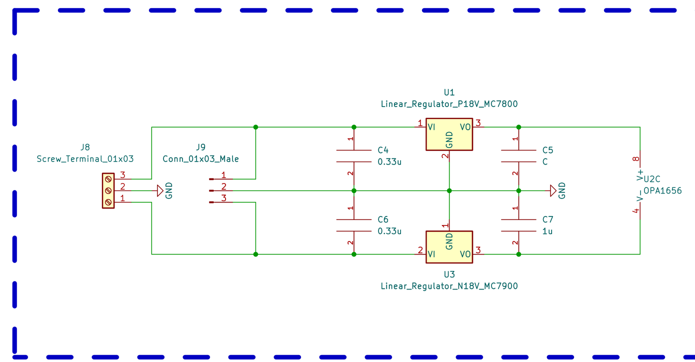
DAC Voltage Regulators



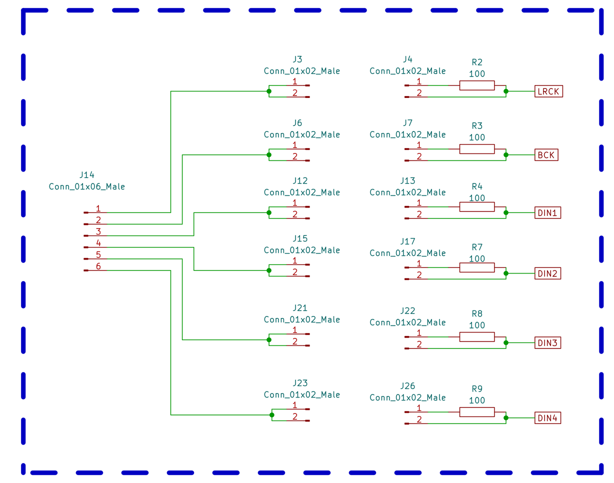
3.3V and 5V linear regulators for the VDD and VCC supplies on the DAC. 470 pF caps reduce noise on the output voltage. 10uF caps also improve noise rejection and transient response. All components recommended on MFR data sheet.

OpAmp Voltage Regulators



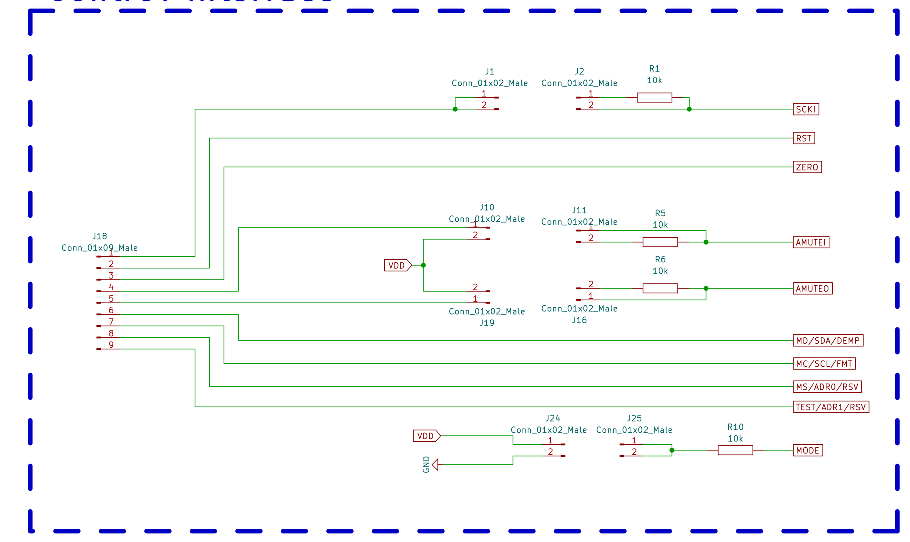
+18 volt and −18 volt linear regulators for the omp amp voltage supplies. Two options for connecting a bench power supply, either through the screw terminal or through the header pins (not both). 1uF and 0.33uF capacitors are recommended on the MFR datasheet to improve stability and transient response.

Digital Audio Input



MFR datasheet for the PCM1690 states that R2 through R7 can be 22 to 100 ohms. I've placed 100 ohm resistors in this subcircuit to limit input current to the digital audio input pins on the DAC. As a back up, I've placed bypass pins in parallel with each resistor so we can use a different resistor on a breadbord. To route signal through the 100 ohm resistor(s), place a jumper connecting pin one on either side of the breakpoint. To bypass the 100 ohm resistor(s), place a jumper cap connecting pin two on either side of the breakpoint.

Control Interface



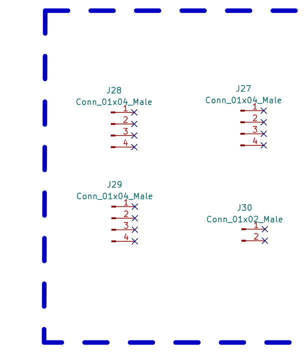
Most of the pins in the control interface section have been broken out and will likely be left floating when using the hardware control mode. I've left options open in case we want to implement a microcontroller in place of both the audio bridge board and the hardware control interface, an idea we can discuss further next quarter.

From the bottom up, tying the mode pin to VDD through pin one of the breakpoint on it's branch enables SPI control mode. Tying the mode pin to GND enables I2C control mode. Leaving the mode pin floating, which is what we'll start with, enable hardware control mode.

R5 and R6 are reccomended by the MFR for pull up. Corresponding AMUTEI and AMUTEO pins can be broken out by connecting pin 1 on the breakpoint for either pin on the DAC.

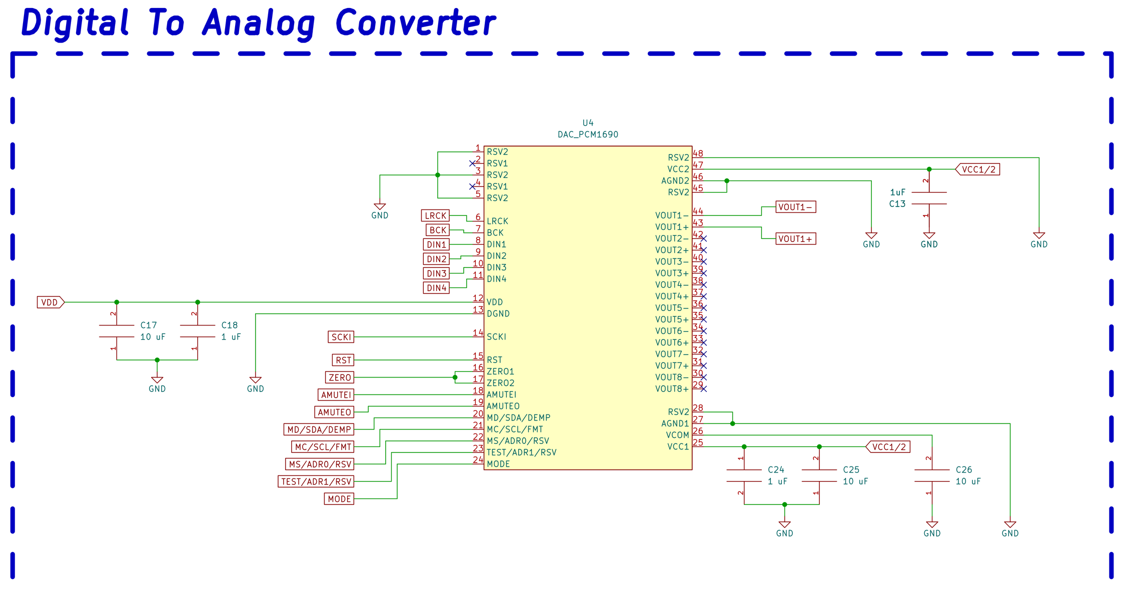
R1 also is also reccomended on the MFR datasheet to limit current into the SCKI pin of the DAC. As seen elsewhere on this board, I've place a breakpoint to bypass R1 if needed.

Breadboard Mounting Pins



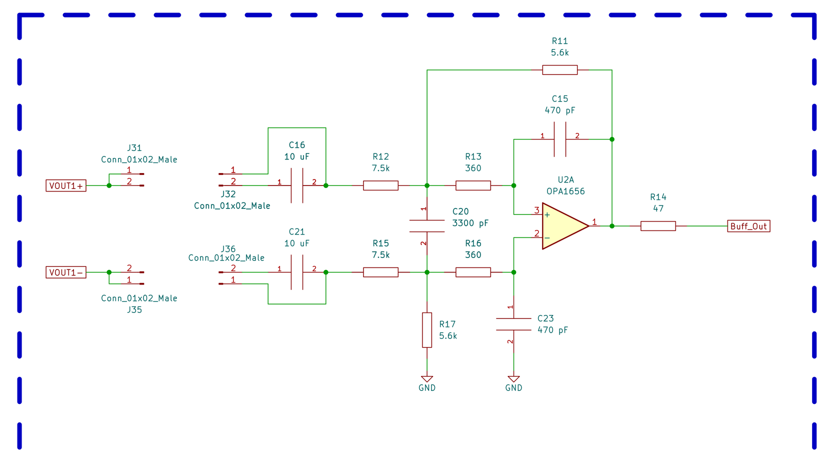
These pins have no internal connection. Similar to the PAA development board they will be located on the four corners of the PCB so it can be mounted on a breadboard.

Digital To Analog Converter



PCM1690 DAC with power supply bypass and decoupling capacitors reccommended on the MFR datasheet. 1uF caps should be places as close to the chip as possible, 10 uF caps can be placed further away but still relatively close to the chip.

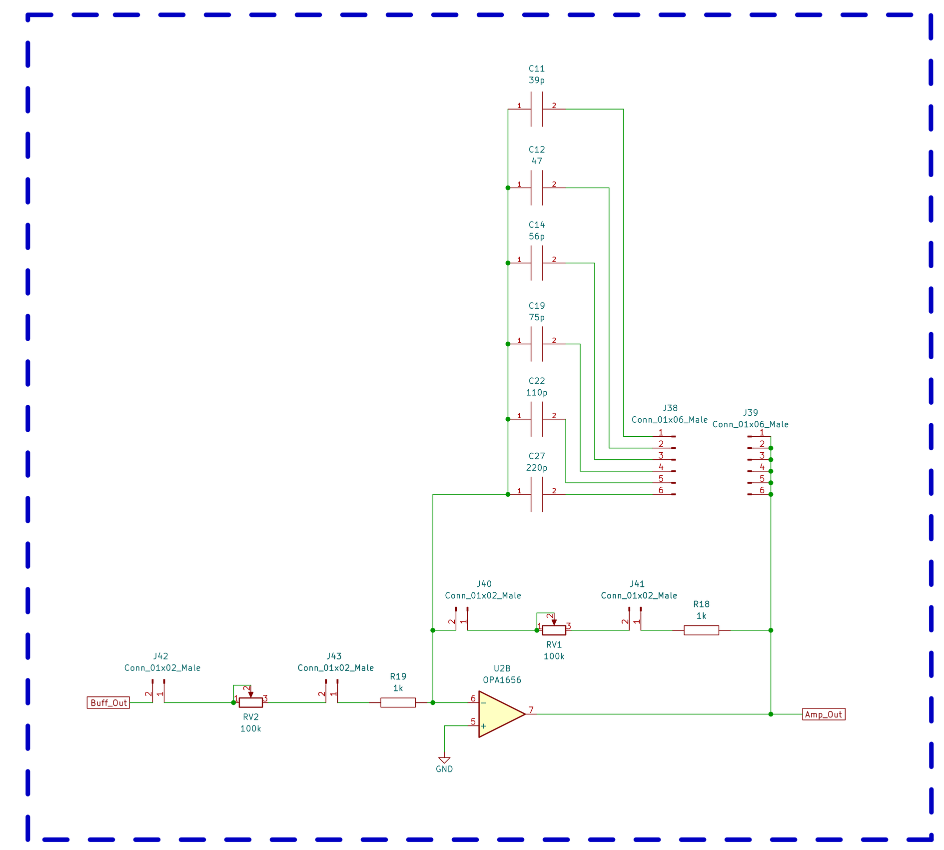
Butterworth LPF/Buffer



Butterworth LPF/Buffer Subcircuit recommended on the PCM1690 MFR datasheet for use in conjunction with the DAC to attenuate out of band noise. I ran a simulation for this circuit to verify the gain and bandwidth (−2.53 dB and 53 kHz respectively) using the RC component selection on the PCM1690 datasheet. The simulation results were consistent with a passband gain of −2.53 dB and a 3dB bandwidth of 53 kHz within 0.1 dB and 1kHz respectively. I decresed the value of C15 and C24 from 680 pF to 470pF (with some trial and error inbetween), and ran the simulation again. By simply decreasing these capacitances, the 3dB bandwidth increased to ~75kHz while maintaining a passband gain of roughly −2.5 dB, which will allow for upper sideband modulation if needed.

Header pins [J27 and J28] and [J33 and J34] serve a few purposes. 1) they are breakpoints to allow us to disconnect VOUT1 from the DAC and measure the signal with an oscilloscope, if all breakpoints are left open. This also allows us to connect a signal generator directly to the buffer subcircuit for additional testing. 2) We can configure the butterworth filter for AC coupling (most likely what we'll need) by connecting pin(s) 2 on both breakpoints and leaving pin(s) 1 open. 3) Alternatively, we can configure the butterworth filter for DC coupling by connecting pins(s) 1 on both breakpoints and leaving pin(s) 2 open.

Tunable Output Amplification Stage



I've included a relatively simple output amplification stage here that can be configured as a rudimentary inverting amplifier, or a first order active LPF with a passband gain greater that unity.

To configure an inverting amplifier, we will leave the breakpoint connecting capacitors C11, C12, C14, C19, C22, and C27 open. This feedback topology employs purely resistive feedback through an equivalent feedback resistance formed by resistor R18 in series with trim potentiometer RV1, and an equivalent input resistance formed by resistor R19 and potentiometer RV2 in series.

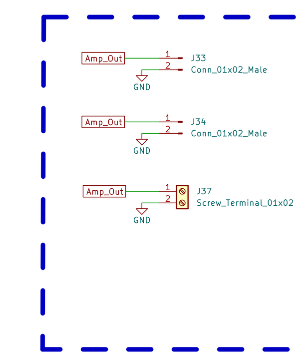
To configure a first order LPF, we can connect a combination of capacitors C11, C12, C13, C16, C20, and C23 in parallel with the equivalent feedback resistance. I have a separate spreadsheet detail component selection for various levels of passband gain and 3dB bandwidth, a little too much information to add here.

As in other subcircuits, I've placed four breakpoints in the output amplifier subcircuit. J38 can be left open to either measure the output voltage of the butterworth filter stage without connecting it to the output amplification stage. The breakpoints on either side of the two potentiometers are in place to allow us to disconnect each pot from the rest of the circuit and thus measure the resistance as we tune the gain.

The output swing of a single ended amplifier is limited, this in theory, can power a maximum of 6 transducers in series. In later iterations, I plan to design a single ended to differential conversion stage to increase the output swing and thus power more transducers. I've found a few topologies for single ended to differential converters and various MFR datasheets, powering additional op amps and generating bias voltages will be a challenge, so I've kept it simple in this design iteration.

This output stage amplifier design may not be optimized, but it will allow us to examine the viability of the OPA1656 as the primary OpAmp chip used in our design.

Amp Output Connection Points



Three options for routing on the output voltage of the output amplification stage. One set of header pins on the bottom of the PCB for routing on a breadboard. One set of header pins on the top of the PCB for routing via dupont wires. Lastly, one screw terminal for routing with a twisted pair.

Sheet: /
File: PCM1690 Breakout Board Draft 7.kicad_sch
Title:
Size: E | Date: | **Rev:**
KiCad E.D.A. kicad (6.0.7) | Id: 1/1