Tech Tips

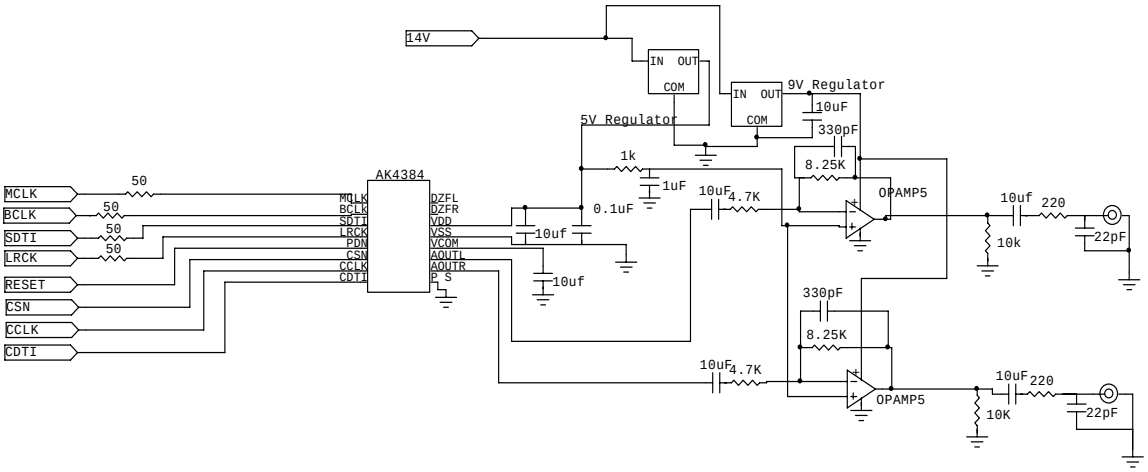
Differential Output DAC's for Consumer Applications

Most consumer audio applications utilize single-ended output DAC's. It is a common perception that single-ended DAC's are less expensive to purchase and apply when compared to differential-output DAC's. Plus, consumer systems do not always demand the performance targets that differential parts provide.

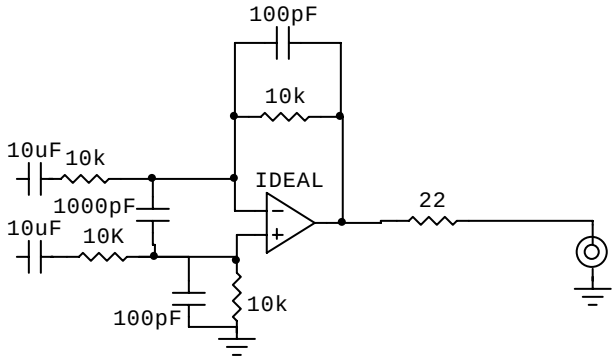
Most audio systems currently in design use switching power supplies to reduce costs. These supplies introduce more noise than linear supplies of the past. As the noise from switching power supplies increases, the trade-offs between single-ended and differential circuits start to blur. Single-ended DAC's offer lower power supply rejection ratios – typically around 20dB. This amount of rejection may not be adequate for maintaining desired performance in the presence of heavy switching noise.

Differential output DAC's are not always more expensive than single-ended versions. For example, AKM's AK4385 is roughly equivalent in price to the single-ended AK4384, a widely used DAC for consumer applications. The differential AK4385 offers the ability to set power supply rejection ratio by using only two additional external resistors, compared to the single-ended versions.

This is a typical single-ended design using two operational amplifiers to achieve the desired 2Vrms output.



If this is converted to a differential output circuit, the second stage changes to a differential to single-ended converter. By doing this the power supply rejection is dominated by the resistor matching of this stage:



GND or Low Impedance Bias Signal for Single Supply.

Resistor matching dominates CMRR of a differential circuit, assuming that the op-amps have matching closed-loop bandwidths. In a typical differential-to-single ended instrumentation amplifier has CMRR from the following equation:

CMRR = 20log (100A / % mismatch)

From this equation, we can calculate possible CMRR for resistor matching. In most cases, resistors taken from the same pack will have very good matching characteristics, irrespective of the absolute tolerance.

0.01%	80dB
0.1%	60dB
1%	40dB

The CMRR in this application translates to PSRR for the overall circuit. The addition of the two resistors allows for much greater power supply rejection in the differential output system. This combined with the internal 6dB PSRR (value for the DAC) allows for a system to be built with much lower cost external components in the power supply, and also reduces the impact from other noise sources on the board that result in reduced SNR.