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The Considerations of Amplifier Circuits

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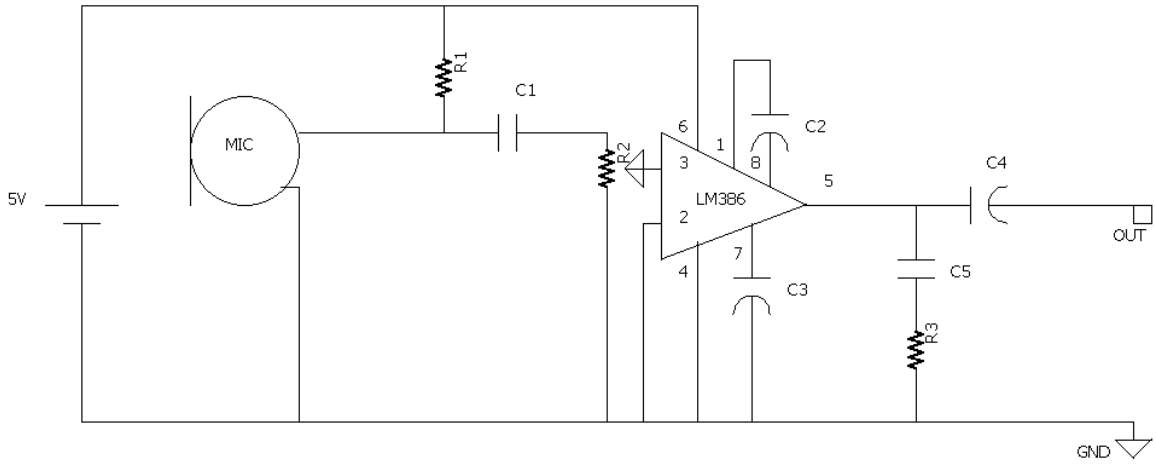
Abstract: Designing the optimal amplifier circuit for your microphone input is crucial. The intensity and performance of the amplifier determine the strength and resolution of the output signal. Using the LM386, 8-pin operational amplifier, has considerations that must be accounted for in the design of the proper amplifier circuit. Microphone selection, supply voltage, strength, and gain must all be accounted for. The combination of these variables can lead to the optimal design needed for many solution applications.

Introduction:

Amplifying circuits and sources are like socks; amplifiers and sources must be matched. Of course, any amplifier can be used with any microphone, but results are undesirable and insufficient. There are many dependent variables that need to be considered when either selecting a microphone or source to use, or designing an amplifying circuit for a desired microphone. In this note we will be utilizing the latter, the microphone is desired because the works best for the intended application.

Look for and op-Amp with high adjustable gain and look for the pinout diagram in the spec sheet. The LM386 IC (figure 1) is being used in this example and has max gain resulting in 200 times the input voltage. The microphone being used is the POM-3535L-3-R, which the spec sheet states the frequency response is 20Hz to 20kHz. But looking at the frequency response curve it's clear that the sensitivity fluctuates greatly in the range of 17kHz to 20kHz (figure 2), which may result in lower cutoff then spec sheet classifies. With that in mind, it is important to select the components shown in the schematic below properly so as to compensate for the variance of the input at high frequencies. It is also important to note the schematic below is interfaced at the output with an Arduino UNO rev 3 to monitor the frequency content being output. Another dependent variable is the supply voltage, in this example 5V is the supply voltage to the amplifying circuit because the Arduino has a 5V supply on the Microcontroller.

Schematic:



Values of Components:

Starting at the 5V connection moving towards the op-Amp we first encounter the pull up resistor, R1, which connects the microphone to positive voltage. Microphones will not operate without the necessary power needed. The other terminal of the microphone is grounded. The value of R1 varies depending on the specific microphone that is in use. Continuing from that point we find capacitor C1, which blocks DC voltage on the input signal and allows AC voltage to pass. When we speak into a microphone, our voice or music is the AC signal; the only part of the signal that we want to pass. The DC signal is only used to give power to the microphone; we do not want it to appear in output. C1 is connected to pin 1 of potentiometer R2 that is used to control the sound volume. The center pin of R2 is connected to pin 3 of the LM386, which is the positive input terminal where the signal to be amplified is applied. Pin 2 of the amplifier is the negative input terminal and is grounded along with pin 4, the ground pin. Pin 6 of the IC is the pin that supplies the op-Amp with 5V, the DC voltage required for the IC to preform. From the pinout of the IC (figure 1), pins 1 and 8 are gain control. These are the terminals where you can adjust the gain by placing a resistor and capacitor or just capacitor between these terminals. In this example, capacitor C2 is used to provide the IC with maximum gain. Pin 7 is the bypass terminal, typically left open or wired to ground. However, in the schematic it is shown to have capacitor C3, which stabilizes the circuit from oscillations that could arise from the IC. Oscillation can distort sound signals, making them unclear or unintelligible. Pin 5 is the output terminal of the IC carrying the amplified signal. Pin 5 leads to a capacitor C5 that acts as a current bank for output. This capacitor drains when sudden surges of current occur and refills with electrons when the demand for current is low. C5 then connects to ground through resistor R3. Pin 5 also shares a node with C4 a capacitor that removes any DC offset from the output of the LM386 amplifier, which could come from the IC.

Resistor R1, when less then 10kOhms is typically called a strong pull up resistor. Pull-up resistors are typically connected to the DC voltage supply (vdd). The value of R1

can vary as mentioned depending on the operating voltage and maximum current consumption of the microphone. In this application the pull-up resistor was chosen to be 6.8kOhms, an easily obtained value. The value was chosen last by powering the circuit and connecting to an Infiniium oscilloscope from Agilent Technologies to display the waveforms. Through a range of resistors it was concluded that for this exact microphone under the conditions had the best response. C1 was chosen to be 0.1uF, large enough to not hinder the input but remove the DC supplied to the microphone. R2 was chosen at a relatively minimal value of potentiometer, 10kOhm, just to understand the variation of sound control. C2, being responsible for gain control between terminals 1 and 8 of the op-Amp was chosen to be 10uF for maximum gain to the input signal because the input from the microphone itself was so low it was difficult to detect. C3, the bypass capacitor, was chosen to be 10uF as well to stabilize against oscillations because it was a value of use for the purpose from known experience in circuit design. R3 chosen to be 10Ohms a small resistance used to ground capacitor C5, which was chosen to be 0.047uF because if the is a need of current the low value of C5, used as a current bank is charged quickly, requiring less charge. Finally C4 was chosen to be very large, 100uF, to guarantee that only the amplified input is seen by the Arduino UNO rev 3, interfaced through A0 the only pin capable of measuring frequency. Capacitor C4 removes any DC offset from the output of the IC.

Conclusion:

To guarantee best results for any microphone/source application where amplification is needed, it is always best to mind the dependent variables of the situation at hand. When designing an amplifying circuit around a given source or microphone keep in mind the following: supply voltage, desired gain, circuit elements available, and the specs of the source. If not designed properly, results can be unwanted and sometimes unavailable. However, designing with these concepts in mind can guarantee a functioning output for accurate results and a successful application.

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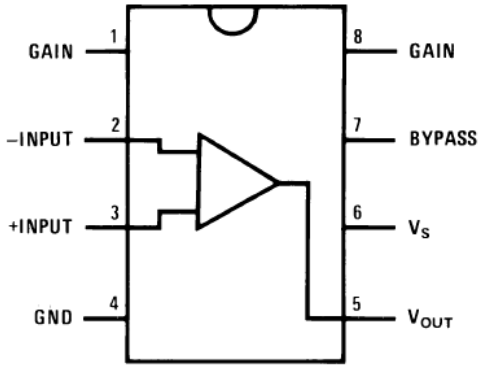


Figure 1: LM386 Pinout

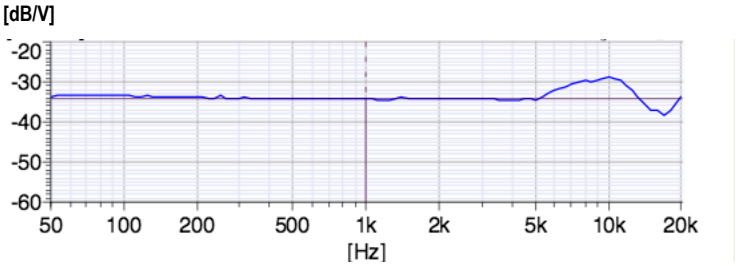


Figure 2: Frequency Response Curve of POM-3535L-3-R

Resources:

http://www.learningaboutelectronics.com/Articles/Arduino-microphone-circuit.php