ECE 341: Junior Design

Accelerated Project Amplifier Design

Written by Mark Ellarma and Evan Cochran

Date: March 2, 2021

1 Schematic

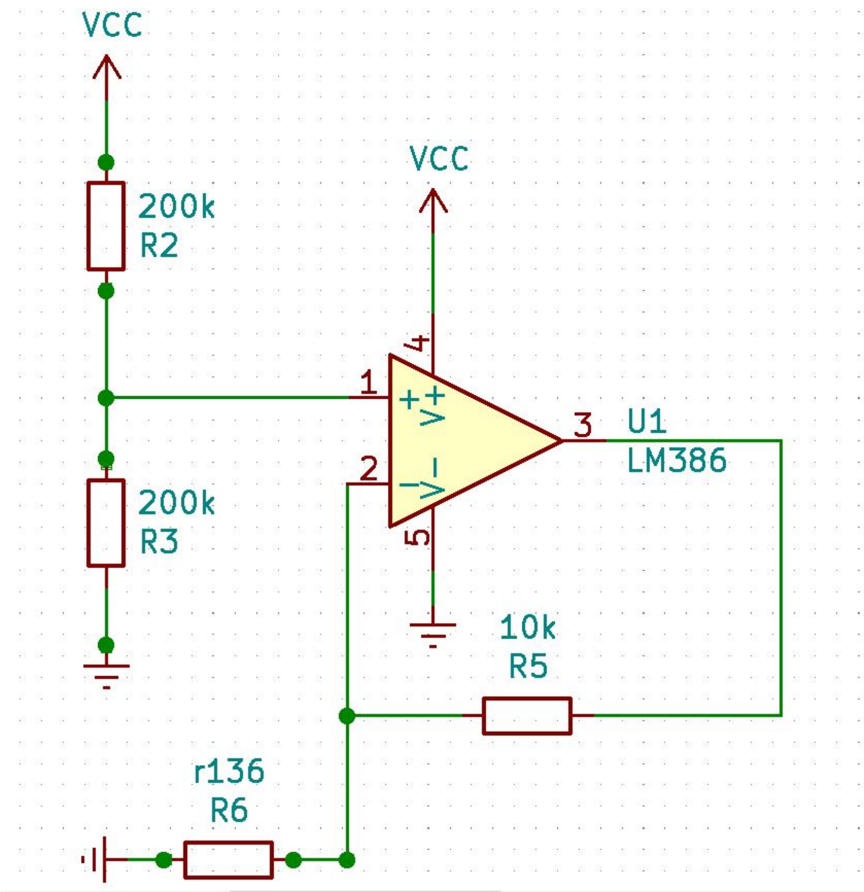

Figure 1: Amplifier Schematic

2 Datasheet

Parameter	Conditions	Min	Typ	Max	Units
Operating Supply Voltage (V_S)					
LM386N-1, -3, LM386M-1, LM386MM-1		4		12	V
LM386N-4		5		18	V
Quiescent Current (I_Q)	V_S = 6V, V_{IN} = 0		4	8	mA
Output Power (P_{OUT})					
LM386N-1, LM386M-1, LM386MM-1	V_S = 6V, R_L = 8Ω, THD = 10%	250	325		mW
LM386N-3	V_S = 9V, R_L = 8Ω, THD = 10%	500	700		mW
LM386N-4	V_S = 16V, R_L = 32Ω, THD = 10%	700	1000		mW
Voltage Gain (A_V)	V_S = 6V, f = 1 kHz		26		dB
	10 μF from Pin 1 to 8		46		dB
Bandwidth (BW)	V_S = 6V, Pins 1 and 8 Open		300		kHz
Total Harmonic Distortion (THD)	V_S = 6V, R_L = 8Ω, P_{OUT} = 125 mW		0.2		%
	f = 1 kHz, Pins 1 and 8 Open				
Power Supply Rejection Ratio (PSRR)	V_S = 6V, f = 1 kHz, C_{BYPASS} = 10 μF		50		dB
	Pins 1 and 8 Open, Referred to Output				
Input Resistance (R_{IN})			50		kΩ
Input Bias Current (I_{BIAS})	V_S = 6V, Pins 2 and 3 Open		250		nA

Figure 2: Amplifier Datasheet

3 Calculations

1. Set the amplifier input common mode voltage to mid–supply voltage. The equivalent resistance of R2 in parallel with R3 should be 10 times larger than R1 so that a majority of the microphone current flows through R1.

$$R_{eq} = R_2 || R_3 > 10R_1 = 100\,\mathrm{k\Omega}$$
$$R_2 = R_3 = \boxed{200\,\mathrm{k\Omega}}$$

2. Calculate the maximum input voltage.

$$R_{in} = R_1 || R_{eq} = 5.9\,\mathrm{k\Omega} || 100\,\mathrm{k\Omega} = 5.571\,\mathrm{k\Omega}$$
$$V_{in} = I_{max} * R_{in} = 7.221\,\mathrm{\mu A} * 5.571\,\mathrm{k\Omega} = \boxed{40.229\,\mathrm{\mu V}}$$

3. Calculate gain required to produce the largest output voltage swing.

$$Gain = \frac{V_{outmax}}{V_{in}} = \frac{3\,\mathrm{V}}{40.229\,\mathrm{\mu V}} = \boxed{74.573\,\frac{\mathrm{V}}{\mathrm{V}}}$$
$$V_{outmax} < V_{rms} \rightarrow V_{rms} = \frac{1}{\sqrt{2}} * 5\,\mathrm{V} = 3.54\,\mathrm{V}$$

4. Calculate R4 to set the gain calculated in previous step. Select feedback resistor R5 as 10k.

$$R_4 = \frac{R_5}{Gain - 1} = \frac{10\,\mathrm{k\Omega}}{74.573\,\frac{\mathrm{V}}{\mathrm{V}} - 1} \approx \boxed{136\,\Omega}$$

5. Calculate C1 and C2 lower corner frequency at 250 Hz with a deviation of -0.5 with resistance seen 100k

$$f_c = f\sqrt{(\frac{1}{pole1})^2 - 1} = 250Hz\sqrt{(\frac{1}{10^{\frac{-0.5/3}{20}}})^2 - 1} = 34.797Hz$$
$$C_1 = \frac{1}{2\pi * 100\,\mathrm{k\Omega} * 34.797Hz} = 45.738nF$$
$$C_2 = \frac{1}{2\pi * 136\,\Omega * 34.797Hz} = 33.631\,\mathrm{\mu}F$$

6. Calculate C3 upper pole frequency at 550 Hz with a deviation of -0.1, with resistor R5 predetermined to be 5K

$$f_p = \frac{f}{\sqrt{(\frac{1}{Pole2})^2 - 1}} = \frac{550Hz}{\sqrt{(\frac{1}{10^{\frac{-0.1}{20}}})^2 - 1}} = 3603.712Hz$$
$$C_3 = \frac{1}{2\pi * 10\,\mathrm{k\Omega} * 3606.712Hz} = 4.416nF$$

4 Notes

1. The frequency values of 250Hz and 550Hz were chosen to be just below and above the desired range of 262Hz and 523Hz. Capacitor C4 and Resistor R6 are omitted from the basis diagram to keep the voltage strictly positive.