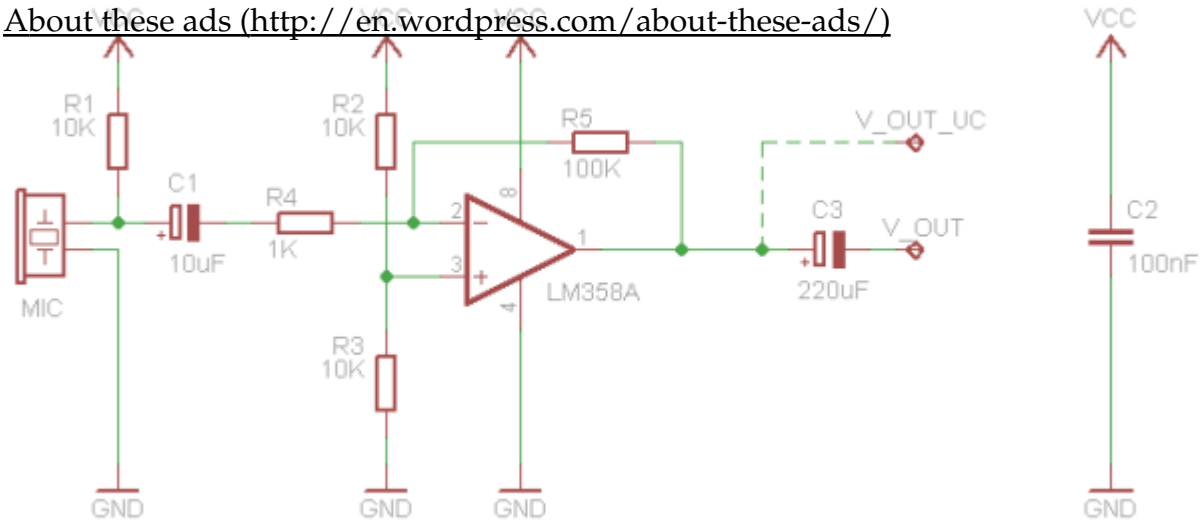
Low voltage. Mostly harmless…

Exploring electronics, programming and photography

LM358 microphone amplifier

MAY 21
Posted by **Dimitar Kovachev**



After the unconvincing performance of the LM386 mic amp (http://lowvoltage.wordpress.com/2011/05/15/lm386-mic-amp/), another design is put to the test. This time, based around a LM358 operational amplifier.

Op-Amps

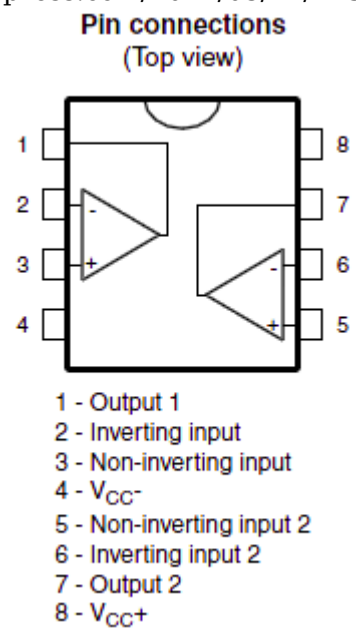
Operational amplifiers (http://en.wikipedia.org/wiki/Operational_amplifier) are high-gain voltage amplifiers. There's a huge amount of information available on how to use them and the guide I followed is TI's"Op Amps for Everyone" (http://focus.ti.com/lit/an/slod006b/slod006b.pdf). The schematic is an "Inverting AC amplifier" (A.3.18, p. 424). From the equations there, the voltages on the two outputs are:

- V_OUT_UC = – V_IN * R5 / R4 + VCC / 2 = – 100 * V_IN + VCC / 2

- V_OUT = -100 * V_IN, as the C3 capacitor is blocking the DC component

(V_IN is the voltage at pin 2)

Op amps do not provide a lot of output power. In-ear headphones can be driven from V_OUT, but it's unlikely that a LM358 will power even a small speaker. For a microcontroller, connected to V_OUT_UC, output power does not matter, only voltage does.



LM358 sound sensor performance

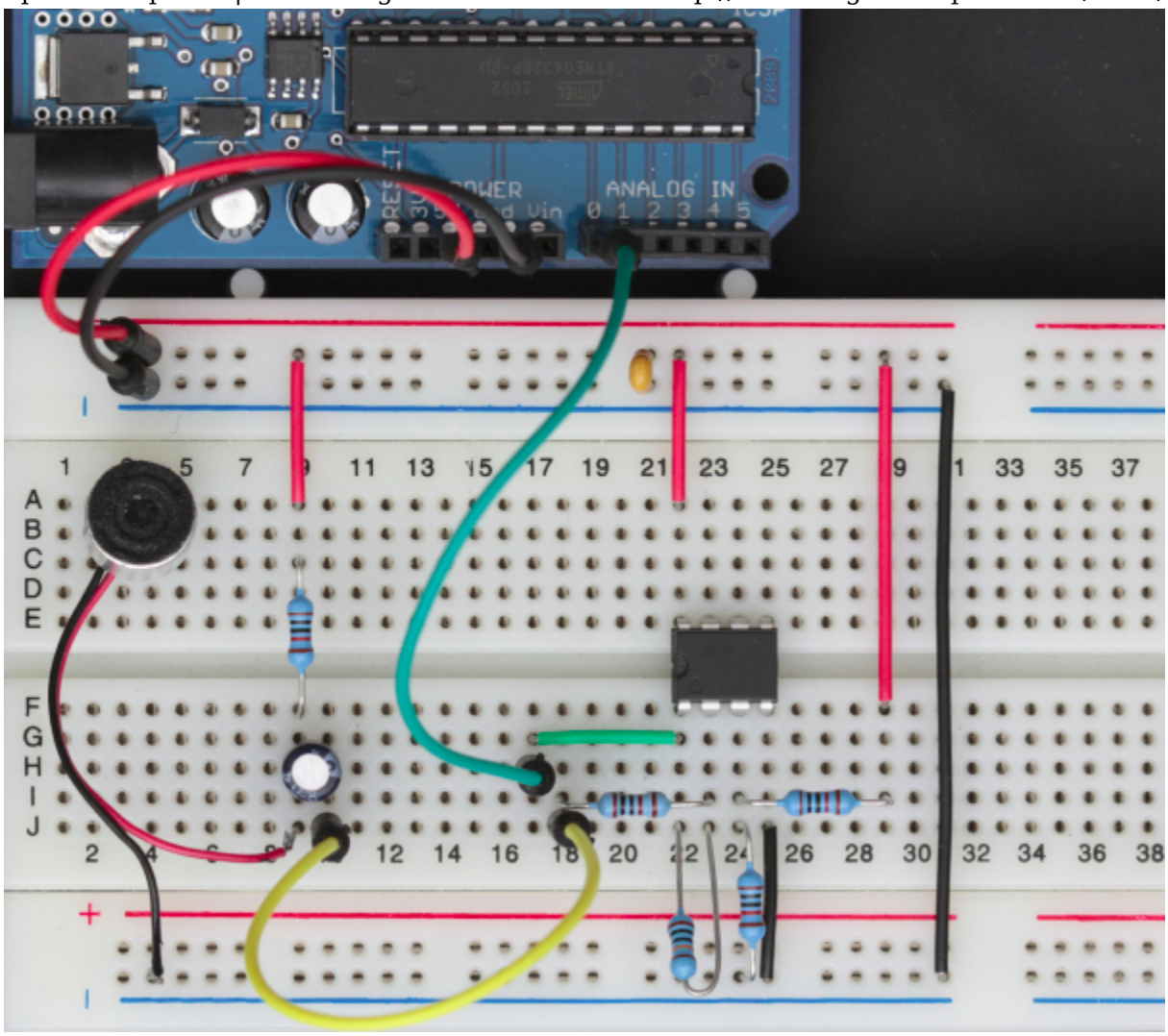
As in the LM386 mic amp (http://lowvoltage.wordpress.com/2011/05/15/lm386-mic-amp/) setup, V_OUT_UC is connected to Arduino's A0 pin and the Min-Max sketch (http://lowvoltage.wordpress.com/2011/05/15/min-max-sketch/) is uploaded. By using different R5 resistor values (10K, 47K, 100K), gains of 10x, 47x and 100x are achieved:

Gain	(Silence)		Loud knock	
	Readings	**Amplitude**	**Readings**	**Amplitude**
10x	510 ~ 512	2	307 ~ 735	428
47x	505 ~ 517	12	17 ~ 754	737
100x	500 ~ 525	25	7 ~ 755	748

Pretty good! The noise level in silence increases linearly with gain. Moving from 10x to 50x gain gives a good increase in the maximum output swing. Pushing the gain to 100x provides only a minor improvement. Overall, the 50x setup gives the best noise vs. output swing results.

The LM358 does not have a true rail-to-rail (0V to VCC) output. The datasheet specifies an "output voltage swing 0V to (VCC – 1.5V)". This means that when VCC = 5V, the largest possible analog reading is in the 715 – 750 range. In order to get an wider output range, a better op-amp should be used.

Current draw was 1.52mA, in the 100x setup



(http://lowvoltage.files.wordpress.com/2011/05/lm358_mic_amp_breadboard.jpg)
LM358 sound sensor on a breadboard (click for high-res)

Parts list

Part	Value	Description
C1	10uF	Microphone coupling capacitor
C2	100nF	Power supply decoupling
C3	220uF	Output coupling
MIC		Electret microphone
R1	1 ~ 10K	Microphone load resistor
R2, R3	10K	Voltage divider: 1/2 VCC
R4	1K	Gain = – R5 / R4

R5	100K	
VSS	3 ~ 30V	Supply voltage

Downloads

- EAGLE schematic (https://github.com/lowvoltage/Miscellaneous/blob/master/LM358_opamp_mic.sch?raw=true) [.sch]
- Min-Max sketch code (https://raw.github.com/lowvoltage/Miscellaneous/master/minmax.pde) [.pde]

Related posts

- LM386 microphone amplifier (http://lowvoltage.wordpress.com/2011/05/15/lm386-mic-amp/)
- Min-Max sketch (http://lowvoltage.wordpress.com/2011/05/15/min-max-sketch/)

Links

- LM358 Datasheet (http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/DATASHEET/CD00000464.pdf) [.pdf], STMicro
- "Powering microphones (http://www.epanorama.net/circuits/microphone_powering.html)" by Tomi Engdahl
- "Op Amps for Everyone" (http://focus.ti.com/lit/an/slod006b/slod006b.pdf), Texas Instruments
- A similar LM358 mic amp (http://circuitdiagram.net/simple-mic-pre-amp-based-lm358.html) design

You May Like

- 1.

Posted on May 21, 2011, in Electronics and tagged amplifier, analog, Arduino, LM358, microphone, op-amp, sensor. Bookmark the permalink. 21 Comments.

Leave a comment

Trackbacks 5

Comments 16

Chris | May 16, 2012 at 09:36
Thank you very much for a good picture of the board and a straight forward write up, it helped me alot!

Dimitar Kovachev | May 16, 2012 at 11:48
You're welcome, Chris!

William Moreno | October 2, 2012 at 17:42
Hi, I am tried to test, followed your instructions here, but I have having problems with noise, please give me any suggestion ?

Dimitar Kovachev | October 2, 2012 at 18:27
Hi, William,

Can you describe your setup in more details? Like, are you using the audio output V_OUT or the microcontroller output V_OUT_UC? How is this noise showing up – unstable Arduino readings or poor-quality audio? What is the op-amp gain set to?

As general suggestions, you should double-check all connections. Are the power rails (+5V and GND) properly routed over all breadboard sections? Then, check if the polarized components (mic and caps) are correctly oriented. Finally, you may try lowering the value of R1, the microphone load resistor, down to 4.7k or 1k

EJ | May 9, 2013 at 10:07
Hey, this is exactly what i was looking for!
Thanks for all the info!

Lukasz Adamczak | July 22, 2013 at 02:10
Hi Dimitar, thanks for a great article.
I'm planning a similar circuit, but getting audio input from a guitar jack.
My guitar signal is up to 600mV peak-to-peak (for the loudest possible chord strum). What values of R5 & R4 would you recommend? I believe I need less than 10x gain to fit within 5V range. Am I right?

Also, can you explain the role of R1? Will I need one for the guitar input?

> ***Dimitar Kovachev*** | July 22, 2013 at 11:49
> Lukasz,
>
> For a 10x gain, you can leave R4 at 1k and reduce R5 to 10k. The R1 resistor is part of the microphone setup, you won't need it in the general case.
>
> Please keep in mind that the LM358 op-amp is probably not the best choice for quality audio applications. This amplifier may work as a proof-of-concept, but you may want to search for better, specialized guitar amplifier schematics.

bharath | September 14, 2013 at 20:48
is it possible to get the Digital O/P from the circuit to drive digital circuit what ill be the o/p voltage

> ***Dimitar Kovachev*** | September 15, 2013 at 10:56
> LM358 does not have a rail-to-rail output and with a +5V supply, its maximum output voltage is ~3.5V. This may be too low for some digital inputs to register as a logic "1" / "HIGH". A comparator (like LM393) or a Schmitt trigger IC may be used to reliably convert the output to digital.

Amir | January 17, 2014 at 14:14
Hi,
Thanks for this post, it has been a geat help!!

I got best results with slightly different values for resistors and capacitors:
C1=100nF
R5=330K
R4 = 0 (Removed it completely!)

Power supply is 3.3V and I also have a low pass filter on the power.
I'm using the V_OUT_UC connected to to an ATMEGA and eventually converting this to audio.
Voice is loud and noise level is low enough.

Why is R4 needed at all in this circuit?

Dimitar Kovachev | February 2, 2014 at 15:54
Hello,

With R4 shorted out (i.e. R4 = 0), the op-amp would work in what looks like a comparator mode, i.e. with maximum amplification. The output would swing to either ~0V or ~3.5V even for slightest changes in the input signal and I'd expect the output to be clipped and distorted.

But I've never tried such a setup and if it works fine for you – that's great!

> ***Amir*** | February 3, 2014 at 08:30
> Dimitar – It did not behave that way. I agree that according to the formulas it should (with an ideal opamp), but it didn't happen this way in real life. It had the effect of increasing the gain but not to a full swing between GND and VCC.

Zinacef | January 18, 2014 at 17:31
Hi I want to connect output to the XBee but ADC range of XBee is 0-1.2V what i should do sir ? and if i want to select frequency in range 40-300 Hz could you guide me ?

> ***Dimitar Kovachev*** | February 2, 2014 at 16:00
> For scaling down the output voltage from 0-5V to 0-1.2V you can use a voltage divider at the output, with a pair of 10k & 3.3k resistors (or a similar pair with a 3:1 ratio). The voltage across the 3.3k resistor will be 1/4 of the output voltage.

Nirbhay | March 19, 2014 at 13:45
Hello,
I am trying to do a small voice recognition circuit using an arduino mega2560 i bought earlier last year. Are there any changes that i will need to make to this circuit for it? I tried but it gave me no results. I checked everything thrice, still. Should i use a pre-amp circuit as well? if yes, which one would you suggest?
Thank you.

Jozef Barca | March 27, 2014 at 14:16
Thanks Man

1. Pingback: **Sound sampling with the Atmega32u4 breakout board+ « bobanaut**
2. Pingback: **Side Project – High Speed Photography trigger « Giant Pong – Making of.**
3. Pingback: **Basic Analog Circuits Exercise – Feb 26 | Kangmunicate Here**
4. Pingback: **Sound analysis in Arduino | Bocho's Blog**
5. Pingback: **Quanto rumore? : QUELog**

Follow “Low voltage. Mostly harmless...”