# Audio Amplifiers You *Can* Build

By Carl Herbert AA2JZ

*The secret to being able to create working circuits, is by building, building, and more building! The more familiar you are with a variety of circuits, reading schematics and identifying parts, the better builder you will become. Here are circuits that are easy to build, and you can use one of them in your next project. Try one!*

New builders are often intimidated by schematics presented in various magazines and books. The exotic looking circuitry has the tendency to "scare away" neophyte builders. The number of parts used to create them or the technical descriptions describing them can sometimes be intimidating.

Here are two *easy to build* audio amplifiers and a basic description of what the parts are and their functions. Even the most inexperienced builder can complete and enjoy these circuits. Most of the parts can be found in the most frugal "junk box," or can be purchased from the local parts source without excessive expense.

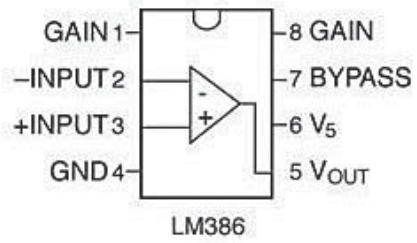
There is ample space on a Radio Shack RS 276-148 circuit board for the audio amplifier created using the LM386. This style of board is good for the new builder. It provides adequate space for parts, has side labels making identification of pin numbers much easier, and can be reused if desired. Just don't allow your soldering pencil to put too much heat on the pads. They will remove themselves from the board if too much heat is applied.

The second circuit, designed by Jim Kortge, will require a larger board, such as RS 276-1499 or similar. I constructed these using "Modified Ugly Construction" techniques, also known as "*Manhattan Style.*" The soldering locations are small pieces of circuit board stock cut and placed on the base "ground plane" using an adhesive such as "Crazy Glue.™"

Not familiar with "*Manhattan Style*" construction? More information about this easy method of circuit construction is available on my website.[3]

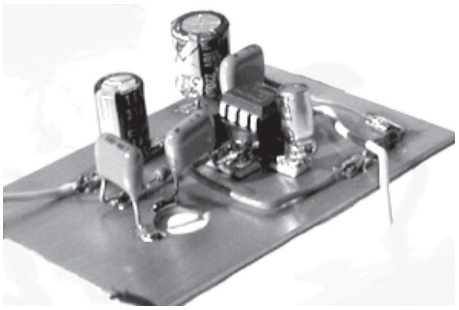
## "Old Faithful"

The first amplifier[(1)] uses the reliable device known as the LM 386 (RS 276-1381). The LM386 is a packaged audio amplifier, requiring only a few external parts to make it fully functional. This eight pin device has been the final audio amplifier in many QRP kits of recent years. The output from it is about 1/2 watt of audio, and will easily drive an 8 ohm speaker or headphones. See Photo A and Figure 1 for a photograph of the basic circuit and the schematic drawing.




***Pinout diagram for the LM 386 Chip***

There are numerous variations of this schematic, all based on the audio amplification provided by the LM386 chip. The components used in the circuit below, enable the chip to perform its function. R1, a 5K (5,000 Ohms) potentiometer, is a panel mounted variable resistor and does not show in Photo A. It is used to adjust the amount of low level audio allowed to enter the device for amplification. Often it is labeled "volume control or gain" on the front panel of a receiver.



This resistor is actually two resistors within one case. As the control shaft is turned, the amount of resistance on either side of center is changed proportionally. As the center wiper approaches the top of its run, the amount of resistance to ground is increased, and the audio becomes louder.

C1, a 1µf (microfarad) electrolytic or tantalum capacitor, is the "coupling capacitor." Its function is to block the DC potential, and allow the audio to pass through to pin 3 of the amplifier chip. Either electrolytic or tantalum capacitors can be used here. The main factors for choosing the type of capacitor are availability or building space considerations.

Electrolytic capacitors are created from two sheets of metallic film, separated by a non-conductive layer called the "dielectric," then wrapped into a cylindrical form. The layer closest to the outside of the device is the negative side, and the positive side is towards the inside. The placement of these layers won't affect C1's operation in the above paragraph, but when used as a filter, placement would become an important consideration. The outer surface, or negative lead, is more susceptible to becoming "tainted" with noise or unwanted signals. When used as a "filter," this lead is placed at ground potential, thus shorting the "filtered-out noise" to ground.

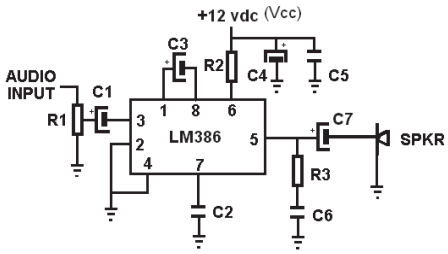



***Figure 1: The LM386 Audio Circuit***

A second method used to manufacture capacitors is by creating multiple common plates of conducting material, one set for the positive and one set for the negative, and separating them with a dielectric. Picture this by holding your two hands in front of you, fingers spread apart. Now mesh them together, but leave an "air space" between each finger. The plates (fingers) on the left are one set of plates, and the fingers on the right are the other set of plates. The air space represents the dielectric material. Greater capacitances in a small space can be achieved using this method.

C3, a 10 µf electrolytic capacitor between pins 1 and 8, is used to connect portions of the internal amplifier sections to create additional gain. C7, the 220 µf capacitor is the "output coupling capacitor." It con-

nects the speaker to the device while isolating the device from the ground connection of the speaker (or headphones).

R2, the 100Ω resistor, (omega being the symbol for Ohms) adjusts the input DC voltage (sometimes labeled as Vcc) to a level more usable by the device. C4 and C6, the capacitors next to it, provide a path to ground for stray noise that could be "hitching" a riding on the DC potential. They are called a "filter capacitors." C4 also provides a measure of regulation of the DC voltage by charging and discharging in proportion to the variations that could be happening to the input voltage.

R3 and C6 are attached to pin #5, the audio output pin. Their function is to develop the audio output level, while isolating the pin from ground.

Variations (additional components) can be found in other publications. These adaptations are to increase gain, obtain a more stable operation, less operating noise, etc. They all begin with the basic circuit.

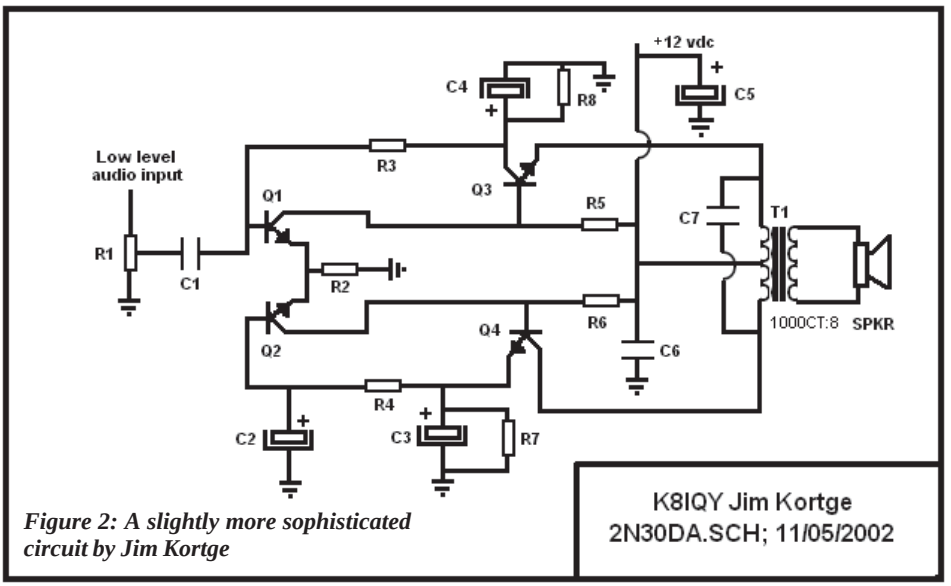


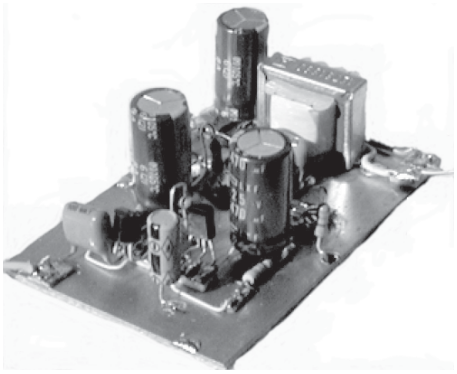

*Figure 2: A slightly more sophisticated circuit by Jim Kortge*

## A More "Exotic" Circuit

The next figure, Figure 2, uses NPN transistors and an output transformer to provide audio amplification. Photo B is a picture of the completed circuit.[2] Again, the volume control is panel mounted and does not show in the picture.

Don't let this circuit intimidate you!

I like to begin construction from the output of the transformer and proceed to the volume control at the other end. Try to make your circuit board as "symmetrical" as possible. That is, make your circuit "look" like the schematic as much as is possible. The output leads from the transformer (RS 273-1380) red and white, are on the outer edge of the board. These are attached to the speaker tabs. The three input leads – yellow, black (center tap) and green – are towards the main



part of the board.

The two NPN transistors feeding the input leads of the transformer, Q3 and Q4, are placed immediately following the transformer leads. Resistors can be placed "on-end" to save space. Q1 and Q2 provide low level amplification for Q3 and Q4.

NPN transistors are used in the circuit. These transistors are created having a "P" type material sandwiched between two layers of "N" type material. The schematic calls for PN2222 units. These aren't the only devices that could be used here. 2N3094, NTE-123, 2N2222, MPS... (or any transistor that converts to NTE-123 as a low level audio amplifier) will work well in this circuit. Just be careful to use the correct "pin output" of the device you have to work with. The ones listed above all have the same "pin output." That is, while looking at the flat side of the device, with the legs pointing downwards, the Emitter is on the left, Base in the middle and Collector is the pin on the right.

## Hey! It Works!

These are "easy to build" circuits, and are a great way for the novice builder to practice building skills, and can result in a working audio amplifier to be use in your next receiver project. Wires should be dressed neatly to aid in finding any troubles you have. I use red wire (RS 278-501) for voltage lines and white (RS 278-502) for the audio connections. To make the ground connections, I use either RS 278-1341, pretinned solid bus wire or snippets of the red or white wire with the insulation removed. The colors aid me in identifying circuit wiring after construction is completed.

Either circuit could be the audio amplifier section for your next project. To test the amplifier, first check your wiring for errors and then check it again. When you are satisfied that all is as it should be, attach negative lead (-) to the ground leg and a positive (+) lead to the Vcc leg and apply power (12 vdc). Unless there appears to be a wiring error (usually denoted by the appearance of smoke), touch the center tab on R1 with your finger. You should hear a low audio hum from the speaker. If not, remove the power from the circuit and go back through the schematic, comparing it to your work, while checking for mistakes.

## Poor Boy Audio Tester

Lacking an audio generator to check the operation of your circuit, your pocket portable radio will also serve double duty as a generator. Remove the outer cover exposing the speaker and its connecting wiring. Turn on the battery powered radio and select a station. *Adjust the radio for a low audio output.* Connect jumpers from each of the tabs on the speaker in the radio and attach the one attached to ground to the ground lead, which is often a black wire (R1 bottom) of your circuit, and the other, which can be any color other than black, to the audio input (R1 top). Apply power to your new circuit and adjust the volume of R1 to a comfortable level.

"Finis!" There you have it! Two audio circuits that aren't difficult to build and can become an integral part of your next project.

Perhaps next time we can attach more circuits to the amplifier and be on our way towards a working receiver!

Happy building!

## Acknowledgements

[1] LM 386 amplifier circuits are found in many publications today. I can't claim to be the author of these circuits. They have been published in countless periodicals, etc.

[2] K8IQY, Jim Kortge, designed this circuit was originally used in the first "2n2/40" rig in 1998, and published in the Winter Issue of QRP Magazine. He also used this circuit in his 2n2/30, " A 30 Meter CW Transceiver," as published in the "Atlanticon 2003 QRP Forum," March 29, 2003. Jim and N2APB, George Heron, the publisher of the "Forum," kindly give their permission to include this circuit in this article.

[3] *Visit my website at* ***http://www.geocities.com/oghmcarl****, and select "articles I have written." (OGHM is what my offspring chose to call me, Old Gray Haired Man. Oh well.)*

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