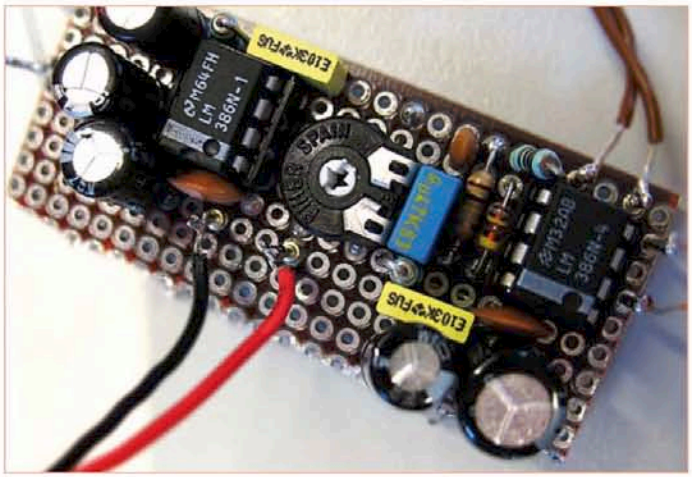
Mini radio gives maxi sound

By Thomas Scarborough (South Africa)

The author was introduced to a very well kept secret, which he will pass on to you through this article... if you promise to keep quiet about it. The secret tells the story of certain audio ICs which double as excellent AM radio receivers. In the circuit we are about to show you, the author has (mis)used the well known amplifier IC LM386N (although it's perfectly reasonable to misuse the LM380N and CA3130E too) for this exact purpose, resulting in a simple, minimalist AM radio receiver with an unexpectedly high sound quality.
In principle, the only things you need to receive an AM radio station are an inductor, a variable capacitor (for the tuning), a (germanium) diode and a crystal earpiece. The inductor and the capacitor create a resonant circuit which is set to the frequency you want to receive. The diode detects the presence of an audio signal, which is then made audible on the earpiece. The beauty of this design is that it allows you to receive two or three strong stations (if you're lucky) with nothing but a long wire antenna and a decent earth connection. You don't even need any transistors or batteries!

The drawback of this solution, however, is the very low sensitivity. Though this is nothing a little amplification won't fix. Fortunately no special high frequency transistors or ICs are required to accomplish this. All you need is a handful of parts available to almost every hobbyist to create a mini radio which produces enough sound to thoroughly annoy your neighbours...

The heart of the receiver is easily recognisable in the left part of the schematic. The resonance loop is built from L1 and C1. The loop resonates to the tiny electric field which is picked up by the antenna, producing a small voltage. This voltage is fed into IC1 for further amplification.
The combination of D1, R3 and C6, which are connected on the output of IC1, take care of the demodulation of the high frequency signal. Basically, the high frequency carrier wave on which the actual information (the audio signal) is modulated using a changing amplitude, is short circuited by C6, leaving nothing but the low frequency audio signal, which is what we want. Actually, D1, R3 and C6 aren't really necessary, since IC1 already achieves a certain amount of demodulation, although the extra parts do contribute to a noticeable higher quality of output signal. Because of the amplification in IC1, you don't need to use a diode with an extremely low voltage drop (like the germanium diode). The LM386 amplifies the signal enough to overcome the 0.7 V drop caused by a regular silicon diode.
Although you could already connect a crystal earpiece (if you can find one) to the top of C6, we recommend using another LM386 for what it's actually designed: audio amplification. This setup will produce enough power to drive a small speaker. Potentiometer P1 controls the volume.

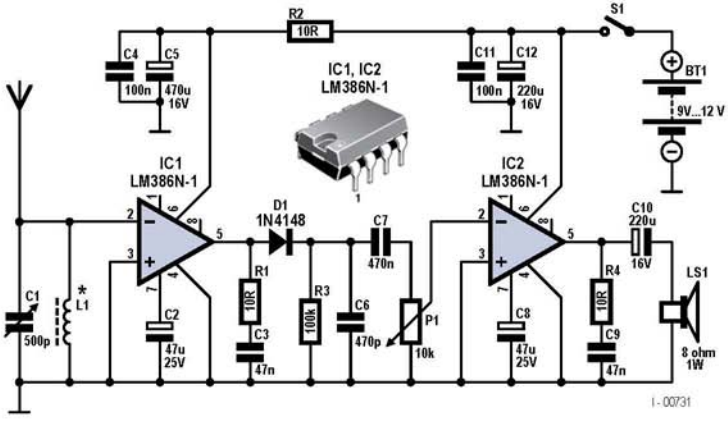


A few details

To increase the stability of both ICs, two RC networks (R1 in combination with C3 and R4 with C9) are connected on their outputs. The 47 µF capacitors (C2 and C8) attached to the bypass connections of the ICs suppress the odd irregularity in the supply voltage. This becomes important when the battery runs flat and its internal resistance increases. Just to be safe, IC1 is decoupled with R2 and C5. Components C4 and C11 add an extra high frequency decoupling. Make sure to use ceramic capacitors and to fit them as close as possible to the IC power pins.
The tuned loop comprising of C1 and L1 is open to any experimentation you like. You could use the antenna coil from an old AM radio, but you could also wind the inductor yourself. We tried both options in our lab, and they worked just fine.
The first prototype was made from a ferrite rod 10 mm thick and 37 mm long, to which we added 100 turns of 0.3 mm enamelled (lacquered) copper wire (CuL). This gave an inductance of 390 µH. The second version was made from 80 turns of 0.4 mm CuL on a ferrite rod 12 mm thick and 190 mm long, resulting in an inductance of 550 µH. With this information, it's possible to calculate the value of the capacitor you need to be able to tune across the medium wave (MW) range. Capacitors with values between 200 pF and 500 pF are best, although it's also possible to use a smaller variable capacitor and a fixed capacitor in parallel.

Construction and operation

Like most of our circuits, this design can be built on a piece of prototyping board. Just keep in mind that this is an RF (radio frequency) circuit! This means that you need to take special care to place IC1 and its surrounding parts close together and maybe even to divide the high and low frequency parts with little metal screens. Special care needs to be taken with the soldering of the tuned circuit, since you are working with very low voltages and currents. Messy construction will guarantee a bad result. Preferably, the finished circuit should be built in to a metal casing (leave the ferrite rod outside the case), and take care that the metal frame and the axle of the tuning capacitor are properly grounded.
The amplifier IC type LM386N is available in four different flavours (LM386N-1, -2, -3 and -4). The versions with suffixes -1 and -3 are best for IC1. The rule of thumb for IC2 is: the higher the number, the more sound the speaker will produce. We advise the LM386N-3 device when using a 9 V power supply, because it can supply around 0.7 watts of audio power into an 8 Ω speaker.
Without an antenna and a proper earth connection, your radio



won't work as it should. A few meters of copper wire suspended across the ceiling should work as an antenna, and a connection with an unpainted metal central heating or water tube is enough for a good earthing. For safety reasons, it's better not to use the ground connection in an AC power socket.

Finally, the circuit works fine with a voltage between 9 and 12 V. A 9 V block battery is a fine power source for the radio, especially because the current consumption is just 10 mA (with the volume control closed).

Happy building and have fun listening to your favourite AM radio station!