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USB Sound Card Hack - ElectroSchematics.com

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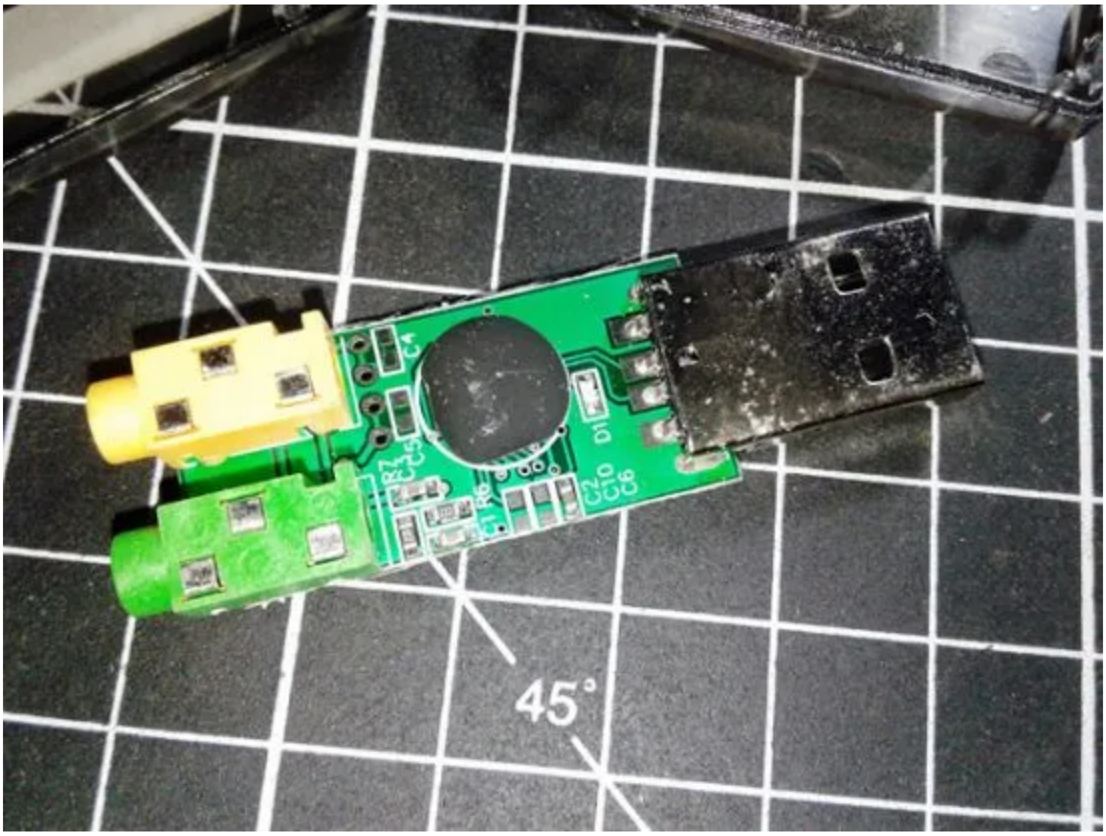
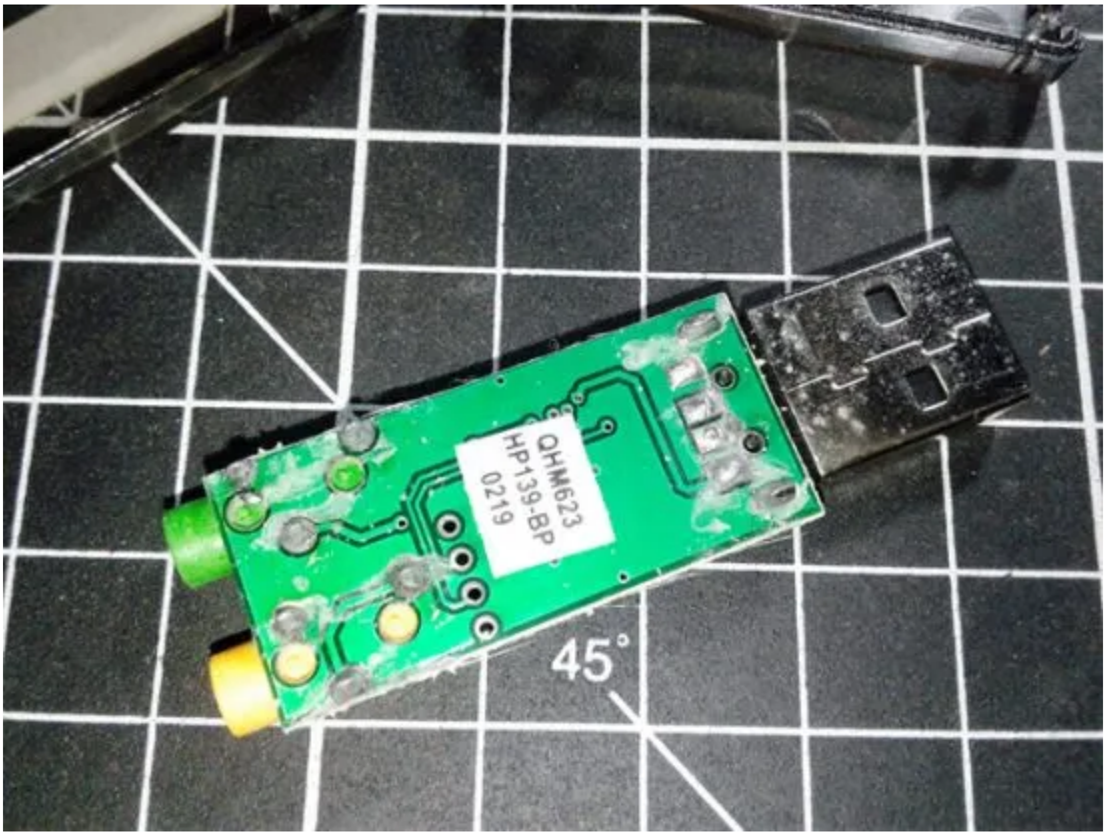
7–8 minutes

Let's begin with the above photo of a cheap electronics gizmo that made me curious. This $1 product that I bought from Amazon is nothing but a USB sound card (integrated two-channel USB audio controller) with audio connectors. Because the tiny device uses a USB port for power, an external power supply adapter is not required. Above all, it’s a true plug-and-play (PnP) device for Windows PCs.

Cheap and cheerful

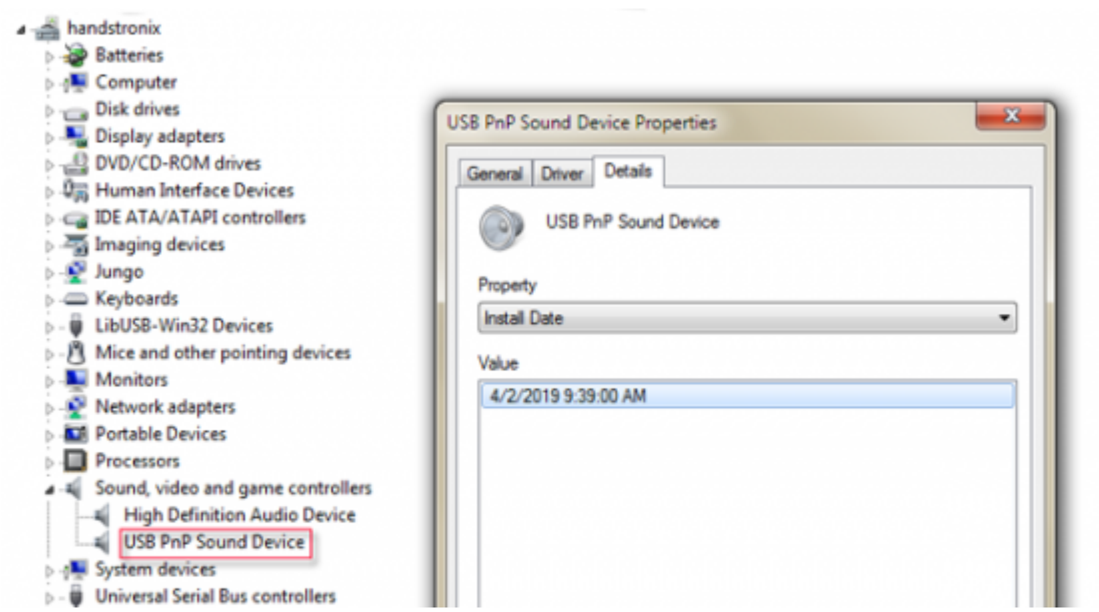
The inside electronics is surprisingly simple because the design is based on a USB audio controller chip by C-Media Electronics Inc. In this device, a chip-on-board (COB) version of the controller (or its clone) is used, and in all probability, it’s the CM108, a 48-pin (LQFP) highly integrated single-chip USB audio solution. All essential analog modules are embedded in the chip, including dual DAC and earphone driver, ADC, microphone booster, PLL, regulator, and USB transceiver. Another popular chip in this series from C-Media is the CM119, another 48-pin (LQFP) highly integrated single-chip USB audio controller but designed specifically for Voice over Internet Protocol (VoIP) applications. Admittedly, I didn't get the precise part number of the chip, but the overall design of this particular device is a mere replica of the application example of CM108, I'm sure.



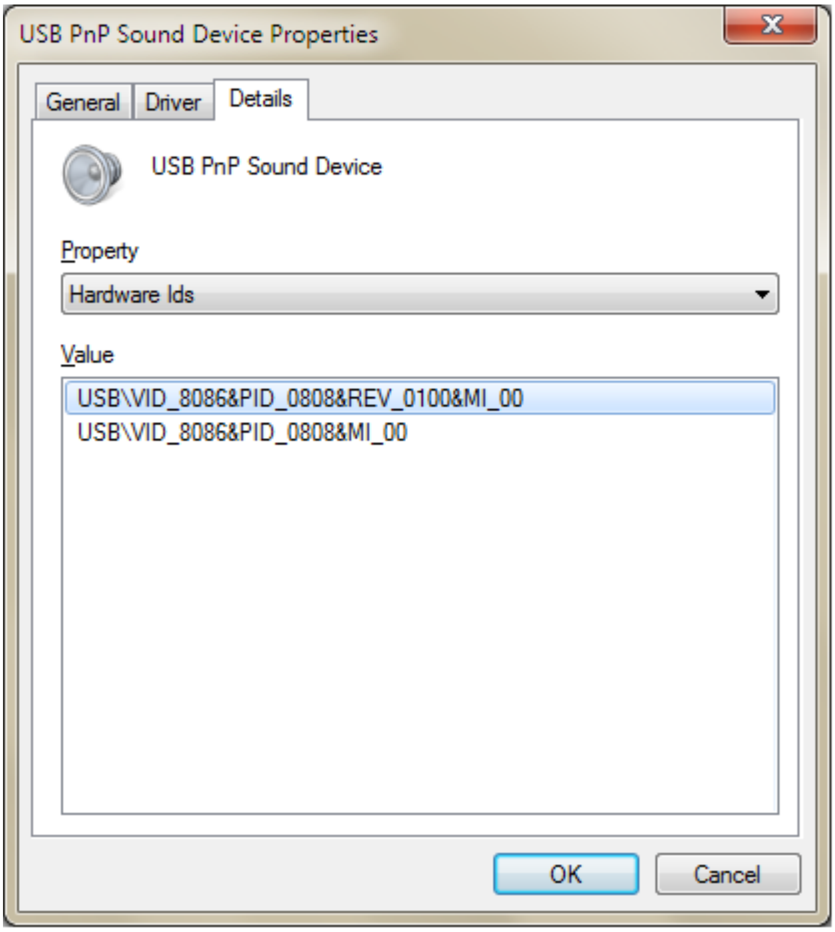


Plug and play

Because the USB sound card is a PnP device, it hardly requires special device driver software. So when the USB sound card is plugged into a Windows PC for the first time, it'll automatically install required device drivers instantly. If installed correctly, we can see the USB sound card as a "USB PnP Device" in the Device Manager.



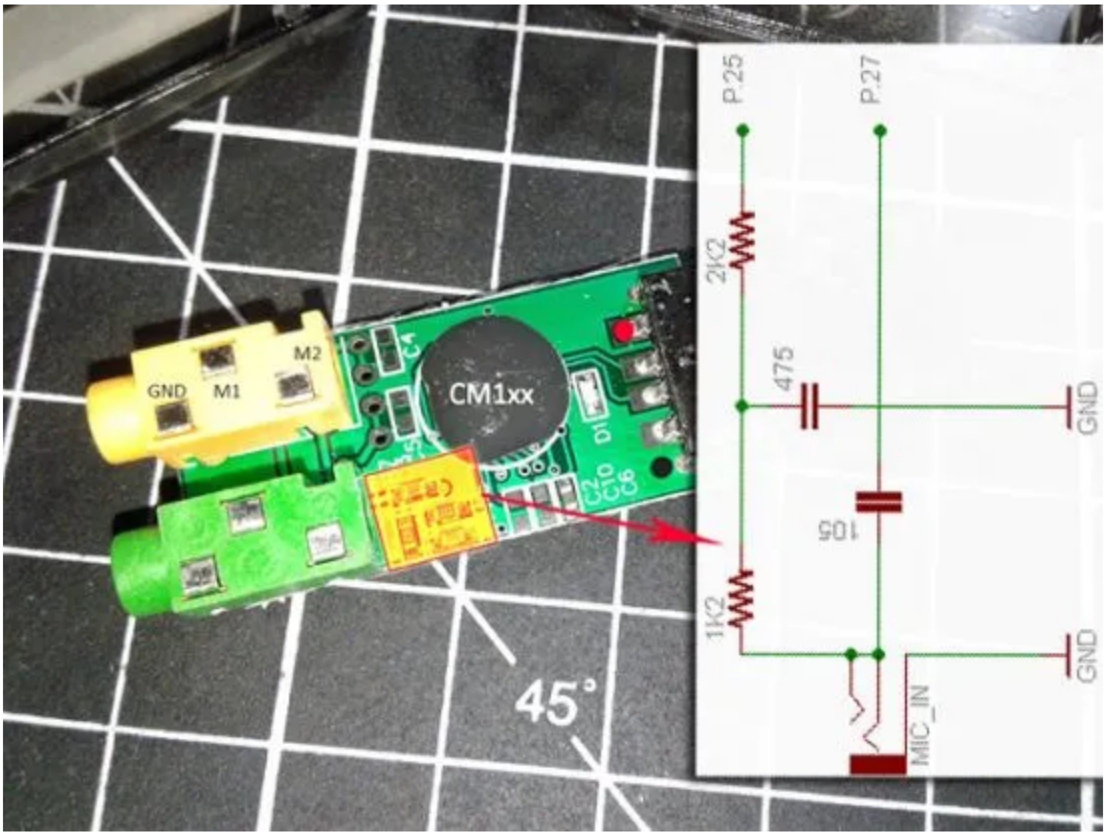
We can see the USB VID and PID in the Device Manager window as well. The on-board LED remains steady in standby condition but starts winking fast in the active state; i.e., while it's handling audio signals.



What's the good of hacking?

If you're working on some PC-based audio projects or experiments, using an external sound card will be more comfortable and safer than fiddling with the internal sound card of your favorite computer. Because USB sound cards are usually hassle-free, you will likely just need to plug it into a vacant USB port to start the fun. Furthermore, your accidental slips never break your internal sound card, thus preventing costly disastrous consequences.

You can obviously connect your hardware to your PC through the microphone input of the USB sound card. However, a closer look at the electronics of my USB sound card revealed that the “monophonic” microphone input is AC-coupled to the chip’s input by a 1-μF capacitor, and the microphone input also has a bias feed (for electret microphone) that is about 2.8 V (measured in an open state).



Simply bumping off the 1K2-Ω resistor (R7) from the PCB will remove the microphone bias, though it’s not important in some situations. For DC coupling, you can bridge the 1-μF capacitor (C3) with a piece of wire (0-Ω jumper). As far as I know, there’s no digital high pass for the microphone input (Pin 27) inside, so CM108 (and CM119) can accept DC input. Nevertheless, a few more modifications may need to be carried out aside from the above alterations to make the USB sound card fully useful as an adapter for a PC sound card oscilloscope. For more convenience, it'd be better to take off the microphone socket from the PCB because then you can easily extend a three-core screened cable (5 V-GND-MIC) from the PCB to the outer world through the space leftover.

The first prep

Before the hacking attempt, do a quick test to check the functionality by connecting one standard electret condenser microphone (ECM) to the microphone input socket (yellow) of the "untouched" USB sound card with the correct ± polarity; i.e., "+" of the microphone to the "tip" of the 3.5-mm stereo audio jack and "–" to its "sleeve." Yes, you're building a simple USB microphone!

Afterwards, you can start the evaluation with the help of Audacity (or similar software). The evaluation can be pretty easily done when you know what you're looking for.

See the partial Audacity screenshot captured while I was only babbling — the microphone pays great attention!

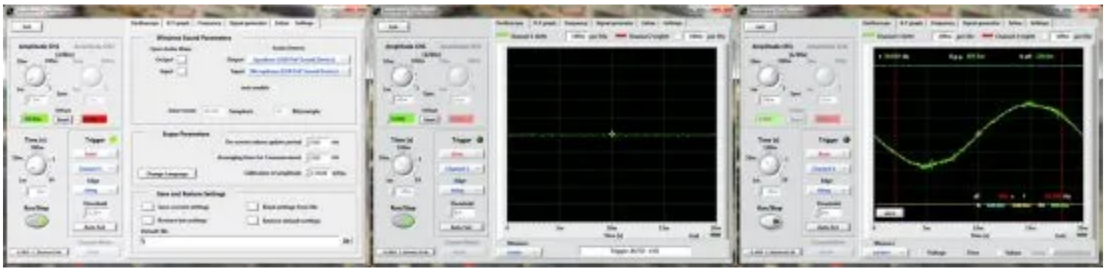
A sound card oscilloscope!

A sound card oscilloscope is a pretty cool PC-based oscilloscope that incurs its data from the PC sound card with 44.1 KHz and 16-bit resolution.* The oscilloscope also contains a signal generator for two channels for sine, square, triangular, sawtooth wave form, and different noise spectra in the frequency range up to 20 KHz. You can take the signal generator's two-channel output through the stereo headphone socket (green) of the USB sound card.

***Why 44.1 KHz that only bats can enjoy? As you're aware, the range of human hearing is 20 Hz to 20 KHz. In digital recording, the Nyquist theorem states that a recording rate should be double the highest frequency recorded. Therefore, 44.1 KHz should be perfect for the human hearing range.**

Besides, as we are looking at amplitudes over time, the bit depth simply denotes the resolution or number of points available to store the amplitude data. For example, 16 bits results in 65,534 points, and 32 bits worth of data gives us 4,294,967,294 data points. Based on many experiences, nothing beyond 16 bits and 44.1 KHz is required as the choice always provides better audio quality that we're able to experience.

Note that the frequency range of a PC sound card oscilloscope depends heavily on the PC sound card, but 20-Hz to 20-KHz range is possible with most sound cards. In principle, the low-frequency end is usually restricted by the AC coupling of the input signal. So the USB sound card, if "hacked" (for DC coupling), will hand a bandwidth of DC (0 Hz) to 15 KHz. The below image is a mix of random scope shots taken just before the hardware hack of the USB sound card (that's to say with AC-coupled input).



Front-end homework

Notably, the microphone input (MICIN) of the USB audio controller chip of the USB sound card is surely an analog input (AI) with a recommended input voltage swing in the 0-V to 2.88-Vp-p range. The frequency response is 20 Hz to 17.6 KHz (44.1 KHz). So what we need is a bit of extra hardware that would scale the oscilloscope's input, preferably with some form of DC bias adaptation, and input attenuation. Read this article to learn more about some front-end circuit ideas.

Finally…

If this article has inspired you without your budget running out of steam, that's great. This is just a prefatory guide, so it's worth experimenting with more powerful and beautiful projects. However, as just about any engineer will tell you, you should aim to keep it as meticulous as you can. Happy hacking!

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- CM108 Datasheet
- CM119 Datasheet
- Audacity Page
- Nyquist Sampling Theorem