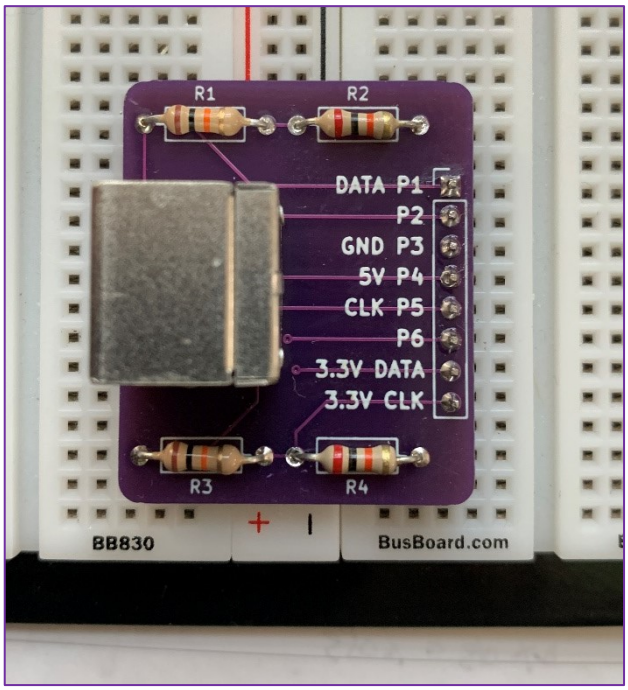
Do you need a PS/2 Breakout Board?

Bruce E. Hall, W8BH



A good PCB label is worth a thousand words.

In my case, I was working on a keyboard keyer and needed a way to test my PS/2 keyboard. It has a mini-DIN-6 plug, and I have an incompatible breadboard. My usual solution is to find a breakout board on Amazon. That method usually works. Usually.

My search came up with a seemingly-good match: a 6-pin PS/2 board from MDFLY. It even has screw-terminals. So, I added it to my cart and waited.

I do not recommend the MDFLY product. The screw terminals get in the way of the pins, making It difficult to use for breadboarding. Even worse, the pin labels are wrong: “1” is really pin 2, “3” is really pin 4, etc. If you connect your keyboard using the provided labelling, you will be reversing the power connections. Not only will it fail, it could ruin your keyboard. Thanks to a few bad reviews, I knew the labelling might be wrong, but I underestimated the problem. It was a mental challenge to undo the error. And, six months from now, will I remember what to do? I doubt it.

So, the most important part of this project is: good labels. My new breakout pins are clearly labelled, in consecutive order, and indicate function. I increased the initial board size to accommodate the labels I wanted.

The last two pins, marked “3.3V”, are duplicates of the 5V data and clock lines at 3.3V logic levels. I used two 10K and two 20K resistors for the logic level conversion. There are many ways to accomplish logic level conversion, including mosfet transistors and dedicated ICs. In choosing the most expedient and junk-box-friendly approach, I learned more about the subject than I bargained for! Read the following page if you have any interest.

The PCB Gerber files for this PS/2 breakout board are on my GitHub page.

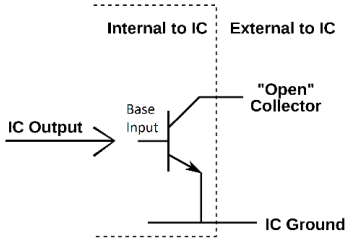
73,

Bruce.

A lesson in logic-level conversion

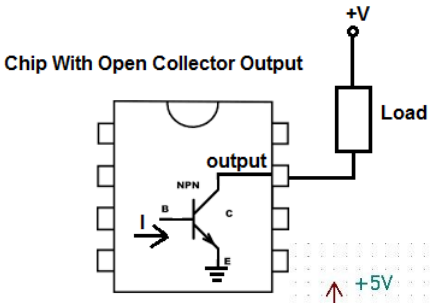
The 5V data outputs on my first breakout board measured **3.33 volts**. Too low! Why?

The keyboard uses open-collector outputs, as shown in the diagram. The data lines "floats" when the logic level is high, and is driven to ground by the output transistor when the logic level is low.

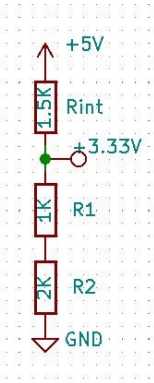


Normally this would mean that the line must be pulled high externally, through a resistor. An example of this is the I2C bus.

However, most PS/2 keyboards have such a resistor built-in, which keeps the data and clock lines at +5V when they are at logic '1'.



In my case, the series 1K and 2K resistors I initially used for my external voltage divider were reducing the output voltage from 5V to 3.33V. In effect, the two resistors form the bottom half of a resistive voltage divider, where the top of the divider is the load resistor inside the keyboard. Can we calculate the value of this internal keyboard resistor? Yes, we sure can! Algebraically

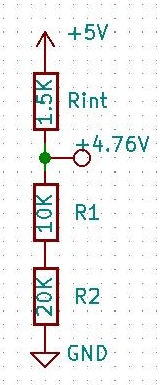


1. Ratio of voltages = ratio of resistances: 3.33V/5V = 3K/(3K+RL)
2. Take the cross-products and divide by 3.33: (3K+RL) = (5V * 3K)/3.33V
3. Solve for RL: RL = 15/3.33 – 3K = **1.5K**

So, the load resistor inside the keyboard must be 1.5K. I have no idea if this is true for all keyboards.

To minimize voltage drop, we must use larger resistances for our voltage divider. The downside is that less current will flow. Fortunately, our MCU does not require a significant amount of current. We can easily reduce the available current by a factor of 10.

Because of parasitic capacitances in the circuit, the RC time constant will increase, reducing the maximum frequency of data transmission. In our case, the frequency is about 12.5 kHz, which is slow enough that it should not be affected by the resistance and capacitances in this circuit.



What is the predicted output voltage if we increase the resistors from 1K/2K to 10K/20K? If the internal load resistor is 1.5K,

1. The ratio of voltages = ratio of resistances: x/5V = 30K/(30K + 1.5K)
2. Solving for x, the new logic 1 voltage outputs = 30/31.5 * 5V = **4.76V**

This is good enough and within spec. The corresponding "3.3V outputs" should be 4.76 * (2/3) = 3.17 V