Re: pull−up/pull−down/short−protection resistor design

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Date: 03/02/05

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Johnson Liuis wrote:
>
> Please do not laugh at these newbie questions.
> I am looking into some sample circuit design and wants to learn
> how to use resistors for the following purposes:
>
> 1) pull−up/pull−down resistor for unused pins. It seems that 10K
> was used for some cases while 4.7K or 150K was used for other
> cases. Any big difference when use different resistors for this
> purpose? Which one can better sustain the noise?
>
> 2) short−protection/current−limiter for pins that support both
> Input and Output. For the data bus, the pins were grounded with
> 150K resistor (for example, D0 to D0 first, then to ground with
> a resistor); for some control pins, 22R resistors were used to
> connect them (for example, RXRDY to RXRDY with a resistor). So
> what is the benefit to connect the data bus to ground with a big
> resistor, to speed the transaction time or sustain noise? What
> is the benefit to connect the pins with a resistor without
> grounding them?

First, consider unused input pins. They normally control some sort of CMOS gate, which has one FET connected to Vcc, and another to ground. At normal logic levels of the input, at least one gate is turned off. However, at some input level both will be turned on, and basically create a short from Vcc to ground. This doesn't do the circuit, or the power dissipation, any good. So some sort of pullup or pulldown resistor is indicated to peg that input level. 10 to 100 Kohm is usually a good choice. It won't draw any power, and will protect the input gate against power line spikes. If you decide to use the input later you can usually ignore the presence of that pullup.

Output circuits can be of three flavors. One is totem pole, where the output pin is pulled hard to either Vcc or ground. These will have good logic levels, barring fighting (of which more later).

Or they can be arranged to pull only high or low. Assume low (the more common case). In that case something external has to supply the high level, and that is usually a resistor to Vcc. This allows multiple outputs of the same type to be directly wired together, and the level is low if any output is low. Also known as the wired and. Again, resistors in the 1 K to 10 Kohm range are often used. The critical thing is the output risetime, governed by the RC time constant, which in turn is the product of the resistance and all the stray capacity on that line (which includes wiring, output pins, and input pins).

Now consider pins that can be configured as either input or output, or can be tri−stated to effectively remove them from the circuit, and are connected to other pins of the same ilk (on the same or different chips). Mistakes happen. Such a pin may be configured for output when it should be an input, and while something else is driving the signal line. This is fighting. The fight is usually resolved when something burns up. This can be protected against with series resistors. If each node connects to the common bus through, say, 470 ohms there will always be at least about 1 Kohm between any pair of misconfigured pins. If the logic levels are 0 and 5 Volts, then no more than 5 mAmps will flow, and the dissipation will be in the resistors. The circuit won't work, but it won't self−destruct.

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"If you want to post a followup via groups.google.com, don't use
 the broken "Reply" link at the bottom of the article.  Click on
 "show options" at the top of the article, then click on the
 "Reply" at the bottom of the article headers." − Keith Thompson
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