ELECTRICAL ENGINEERING

Why place an inductor between Vin and Vdda (AVDD)

Asked 1 year, 10 months ago Modified 1 year, 10 months ago Viewed 1k times

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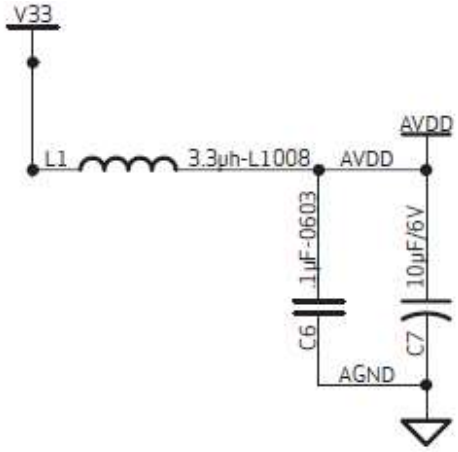
So I know this must be a filter of some sort, just like you place caps in on power supplies as close as possible to the IC's that you're working with. But I'd like to know a bit more in detail about the function of an inductor between Vin and the AVDD pin of a IC (such as the STM32F303RET6).

In another stack this example was given that shows an inductor just like I mean.



Now, I'm making a PCB with the STM32... and the datasheet does not show typical applications with such a inductor, but a schematic I got from some source with the STM32 does have an inductor between +3v3 and AVDD of the chip but does not have an inductor between +3v3 and VDD. Why is that?

Please excuse me for the maybe basic question but I'm trying to obtain some more common knowledge on the matter. This is why I'd very much like detailed explenations and tips/tricks for future designs. What are the rules of thumb on this matter?

power-supply analog inductor

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asked Dec 14, 2020 at 10:43
Mart
206 ● 1 ● 11

1 Have you read the application note AN4206 called Getting started with STM32F3 series hardware developement, which discusses analog supply filtering? – Justme Dec 14, 2020 at 10:51

I did look into that, and they do talk about 'an external filtering circuit' but that is litteraly the most about this I could find – Mart Dec 14, 2020 at 11:28

That's a pretty good way to keep digital switching noise out of the analog supply. – user_1818839 Dec 14, 2020 at 13:10

2 Answers

Sorted by: Highest score (default)

3

You are right, this is a filter - in particular, it is a `lowpass LC filter`. It is used on the analog supply to remove high frequency noise, which would impair the ADC's and/or DAC's accuracy. This is not need on the normal VDD supply lines, as the noise is less likely to impair the function.

Intuitively, an inductor's impedance rises with frequency, and a capacitor's impedance decreases with frequency, so only low frequencies can pass through this filter. High frequencies are shunted to ground.

Mathematically, the cutoff frequency is given by:

$$f_c = \frac{1}{2\pi\sqrt{LC}}$$

In the design given, the $f \approx 30\ \mathrm{kHz}$ so noise above that frequency, typically from an SMPS in this sort of system, will be attenuated. For an LC filter, the cost/size of the inductor usually constrains the design. The values here are fine to get started; if you were making 10,000 of the design you would think about whether it was needed, or if you could change to a cheaper RC filter, or smaller L etc.

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edited Dec 14, 2020 at 11:02

answered Dec 14, 2020 at 10:56

awjlogan

7,349 ● 2 ● 27 ● 43

3

The VDDA pin is used as a power supply pin for all the sensitive analog functions inside the microcontroller.

This includes DACs, internal oscillators, PLLs, op-amps and power supply supervisor circuits among other more traditional analog functions.

Therefore the analog supply is separate pin from the digital supplies, to be able to isolate noisy digital circuitry from the sensitive analog circuits that perform better when there is little noise.

The inductor and the capacitors form an LC low pass filter to provide less noisy analog supply voltage for the MCU.

Selecting the LC values is a bit difficult as it depends a lot on what is supplying the power and it also depends on the specific requirements of the MCU.

The MCU appnotes do specify the recommended capacitances, so the problem is more selecting a suitable inductance value.

In general, if there is a switch mode regulator providing the supply, the LC filter cutoff frequency must be significantly lower than the switching frequency, as LC filter cutoff frequency is also the resonant frequency, so it can even amplify the noise unless the LC filter has damping.

Also the cutoff cannot be too low so that the voltage rises and falls quickly enough during power-up and power-down of the MCU.

This is exceptionally tricky with this specific MCU as it requires that VDDA is always above or equal to VDD. So any filter on VDDA that slows it down will violate the MCU specs. And VDDA must not be more than 0.4V above VDD.

So using LC filter on MCU analog supply pins is a difficult subject and many things can go wrong. ST reference designs typically use ferrite beads instead of inductors on VDDA supplies, and if there is too much noise, there are simpler options than an LC filter to improve the design.

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edited Dec 14, 2020 at 12:49

answered Dec 14, 2020 at 11:12

Justme

98.7k ● 2 ● 75 ● 200

Ah, I don't know the ST products and assumed VDDA was just for the ADC/DAC - good point on the "hidden" analog bits :) – awjlogan Dec 14, 2020 at 11:28

Very nice explanation! Could you maybe tell a bit more on how to choose these values? I know it might be different in each application but are there general rules of thumb? – Mart Dec 14, 2020 at 11:30

Nice. Pay attention too to analog GND paths. Where does it connect to digital GND? Does your chip have a VSSA as well as VDDA? A fastidious designer might set analog input to a fixed, low-noise DC potential, and collect analog data for an FFT - to see how low the noise floor is, and if it contains spurious frequency components. – glen_geek Dec 14, 2020 at 14:26