How to choose MLCC cap values for power supply decoupling?

Asked 5 years, 8 months ago Active 5 years, 8 months ago Viewed 979 times

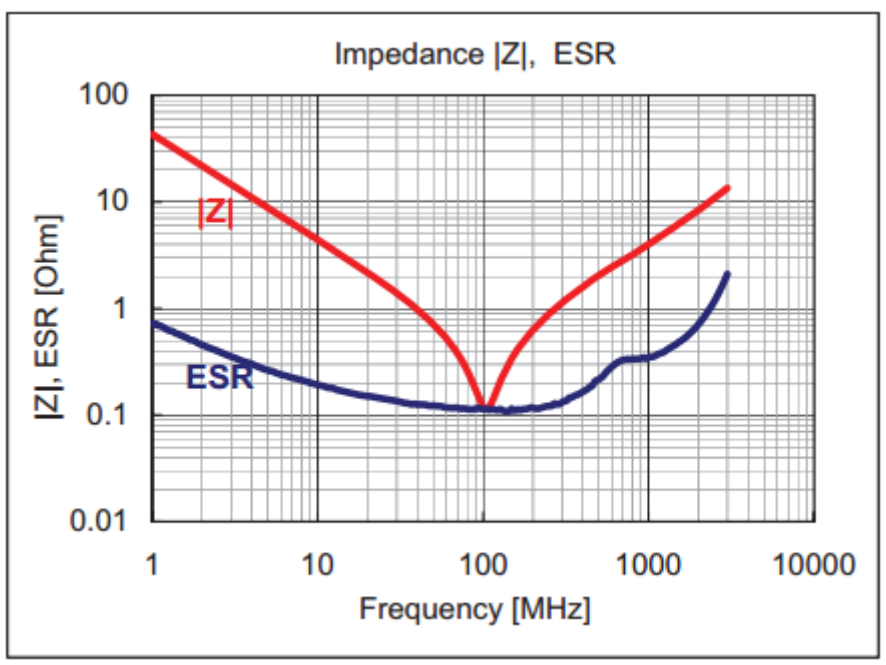
2

I've read that it's best to use several MLCC caps with different values to filter out as much the varied frequency noise as possible.

On the output of the voltage regulator, I see some noise in the 100MHz frequency that I would like to filter out. According to datasheet, this noise is expected as a side effect of the switching effect of switching transistors inside the switching regulator (fsw = 1.5MHz). The 100MHz noise is associated with the switch-node ringing resulting from the parasitic inductances and capacitances.

What should I look for in an MLCC that would best filter out this 100MHz noise as much as possible?

I already have 10uF and 0.1uF caps, and considering adding a 3.9nF cap. The 3.9nF was selected since I see this cap has the lowest ESR and lowest Z at the 100MHz frequency. (The ESR and Z graphs show a V that hits about 100MHz at the lowest point).



Would this be a suitable capacitor to filter out the 100MHz noise?

What impact if any would the SRF (self resonance frequency) would have on the output, and should I be concerned with this? It appears the SRF of this capacitor would be around 100MHz (as the f where Z == ESR is 100MHz).

If I go even lower in value such as 3.3nF, the SRF shifts higher, but I will gain a higher ESR and Z at the frequency I'm trying to filter out.

What's the best way to select MLCC values?

power-supply | capacitor | switch-mode-power-supply | decoupling-capacitor

Share Cite Follow

edited May 16 '16 at 9:33

asked May 16 '16 at 6:08
Adam B
407 ● 7 ● 18

where this voltage goes (Load details), How you got captured 100 Mhz noise (probing), find out the reason for 100 MHz noise. what is regulator Switching frequency. – user19579 May 16 '16 at 6:37

You typically need a LC filter (with losses) to get rid of switching noise on power supply output. – Master May 16 '16 at 8:02

100MHz noise is highly unlikely to be from a switch mode power supply; I suggest you find the source of this noise first. As far as self resonance of MLCCs goes, I thoroughly answered that some time ago: electronics.stackexchange.com/questions/193608/... – Peter Smith May 16 '16 at 8:26

1 @user19579, the reason for the 100 MHz noise is an artifact of the switching effects of the voltage regulator. The switching frequency is 1.5MHz, however, the 100MHz noise occurs to due to the switching effect. – Adam B May 16 '16 at 9:24

@PeterSmith, I believe the SRF is typically the point where ESR = Z, which is also typically the point where Z is the minimum. I have attached a plot of the 3.9nF

@PeterSmith, I believe the SRF is typically the point where ESR = Z, which is also typically the point where Z is the minimum. I have attached a plot of the 3.9nF capacitor that I was considering, showing the SRF to be around 100MHz. – Adam B May 16 '16 at 9:26

using an LC filter or adding a ferrite bead between the power supply and the main bulk capacitance will help a great deal in reducing VHF noise, probably more than just a capacitor on its own – Sam May 16 '16 at 10:04

1 Answer

Active | Oldest | Votes

3

For filtering SMPS ringing noise, you need a snubber. There are many guides on designing such. Ridley engineering is one and it's freely available: http://www.ridleyengineering.com/component/content/article/15-dc/127-71-designing-snubbers-for-nonisolated-converters.html?showall=1&limitstart=

Here's another: http://cfile9.uf.tistory.com/attach/2706B1465448758E2E7E4E

If you need more thorough reading, consider buying Rudy Severn's book on it. There are various different ways of designing these, simple RC snubber is the most popular one, followed by a RCD snubber. For high power/efficiency designs you can also design a lossless snubber where the energy is stored in a capacitor and fed back into the system.

On subject of using different size capacitors in parallel, this has a side-effect of creating an impedance spike as the inductances and capacitances of different components resonate. It may or may not matter but you're not damping that particular frequency much if at all.

edit Old Unitrode seminars have good stuff. Not to mention the way they draw basic SMPS circuits would give one our regulars a fit.
http://www.ti.com/general/docs/litabsmultiplefilelist.tsp?literatureNumber=slup100

Share Cite Follow

edited May 17 '16 at 8:36

answered May 16 '16 at 12:11

Barleyman
3,326 ● 8 ● 22

If I add the 3.9nF capacitor, that effectively reduces the impedance of the 100MHz component to 0.01 Ohm (previously it was around 1 Ohm without this capacitor), wouldn't that reduce the 100MHz noise? – Adam B May 17 '16 at 2:48

@AdamB It depends. Ringing is caused by component capacitances and inductances and just adding capacitance would likely change the ringing frequency, not to mention you'd be dissipating a lot more power. If you look at the design guides the capacitor itself doesn't do much except halve the ringing frequency. Different components and topologies need the snubber components in different places as well. – Barleyman May 17 '16 at 8:29