There were some discussion concerning the correct powering of an ESP8266 amongst my viewers. So, I thought, I use the things we learned in the latest videos and use it to find the influence of different measures on the behavior of our ESP8266.

1. Can we enhance stability of ESP8266 with capacitors across the power pins? What is the optimal size and technology?
2. What about this, if we use a voltage regulator?
3. How can we reduce power consumption during deep sleep, with and without voltage regulators?
4. Can we use a NodeMCU board for deep sleep low energy applications?

I will use two different ESP8266. One bare bone, without any resistors and capacitors mounted on a small PCB, and the other, mounted on a PCB with the necessary resistors for chip enable and GPIO15 and a HT7333 low dropout voltage regulator.

In the first test, I use the bare bone ESP and connect it to a 3.3-volt bench power supply. I measure the current using the µcurrent gold discussed in video #84. The results are basically the same as in video #47. The bigger the capacitor, the smaller the current spike. Viewer asked me, if these spikes are dangerous for power supplies or voltage regulators. These days, most voltage regulators have over current protection. So, this is not dangerous to them. But, what do they do to protect themselves? They lower the voltage during this over-current period. And that is potentially dangerous for our ESP, because, if it does not get enough voltage, it crashes. Officially, the specifications of the ESP8266 says, that it operates from 3.0 – 3.6 volts. But at room temperature, it works also at lower voltages.

In addition to the potential voltage drop of the regulator, the wires from the power source to the ESP have a small resistor in series, which, again, drops some voltage. According Ohm’s law, they drop more voltage with higher currents. So, the expected effect at the power pins of the ESP is, that the voltage fluctuates with the current spikes. The better the power supply or the lower the resistor of the wires, the smaller this effect.

Let’s check: We measure the voltage across VCC and GND pins of the ESP. Without a capacitor, the voltage drop in my configuration is 0.4 volts. This is mainly because of the resistor of the leads and the breadboard. If I add just one ohm to this wire resistance, I get a voltage drop of 0.6 volts. Let’s assume we power our ESP with 3.3 volt. Then, the lowest voltage is 2.9 volt without the additional resistor, and 2.7 volt with the additional resistor. Which is already outside the specifications of the ESP. This means, that under bad conditions like high or low temperature, it can crash from time to time. And this is, what some users of ESP8266 experience.

What are the options to deal with this problem? We could use a higher voltage, e.g. 3.6 volt. This is the maximum of the specs. Then, of course, we would still be in specs for both above conditions. Or we reduce the resistance of our leads by shorten it, or use thicker wires. If the resistance comes from the inner resistance of the battery, we could use a bigger one.

But, because the spikes are very short, we could also try to reduce them with either a capacitor across the power pins or by an inductor in series with the lines. Together with lower spikes, we expect also less voltage drop. I did this in video #47, but now, we look at the voltage drop: With a capacitor of 100 µF, 330µf, and 1000 µf. It is important, that this capacitor is close to the power pins of the ESP, because we to reduce the resistance between the capacitor and the ESP. Now, the voltage drop is less than 0.2 volt, even with the resistor from before. Problem solved. We never get below the 3 volt.

If we add an inductance, the problem becomes bigger, not smaller. This is not, what I expected. But if we look at the 470 µH inductor, we see, that it has a 1.4-ohm resistor, which is in series with all other resistance. This seems to be the main effect, at least for this inductance. I tried with different inductors, but with no success. BTW: An inductor without a capacitance regularly crashed my ESP.

Summarized, we can say: for long wires or weak batteries it is good to use a big capacitor across the power pins of the ESP, or you increase the voltage of your power source.

Batteries like the Li FePo4 from my video #64 and #65, change its voltage during discharge. Smaller voltage drops during the current spikes mean, that we can use more of the battery capacity before our ESP becomes instable. Just as an indicator, my bare bode ESP crashes at about 2.3 volt at room temperature of about 22 degrees Celsius. Very good compared to specs. Needless to say, this is without any pins used for a real application. Maybe I will heat and cool a device in a future video to find out, if this behavior changes with temperature.

So, we can go on to our next topic, the deep sleep. Without any capacitor, we measure around 22 µA deep sleep current. If we add our normal 1000 µF capacitor, we get 24 µA. If we now add a 1000 µF SMD tantalum capacitor, we get a surprise. The current increases to 45 µA. So, the capacitor has a leakage current, which is bigger than the sleep current of the ESP. As one of my viewers told me, that this is a well-known feature of these capacitors. If I replace it with a 330 µf SMD tantalum, the current drops to 24 µA. So, there is a big difference between the two capacitors. I do not know, if better 1000 µF capacitors exist. For me, it means, that I will use an aluminum electrolytic capacitor for my low energy applications

Summarized, our bare bone ESP with the right capacitor is a good choice for low power applications. Because the NodeMCU boards have a few more components and generally a different voltage regulator, they cannot be used for low power applications. Even in deep sleep, they still draw about 10 mA which is way more than the ESP itself.

Now, let’s go on with the ESP and a LDO voltage regulator. This is a typical application if we use a Lipo battery or a 5 volt power source. I start with 5v input voltage and the 10 µF capacitor required by the data sheet of the regulator. Now, the voltage drop is one volt. This is, because this regulator cannot react very fast and is only specified for 250 mA current, it drops voltage, exactly as expected.

I checked my NodeMCU boards, and most of them use the AMS1117 voltage regulator. They use only small capacitors, and the show very similar behavior. The only exception is the Wemos D1 mini, which uses another voltage regulator which is much better suited for this purpose.

So, just using a 10 µF capacitor is not recommended. We need a much bigger capacitor. Let’s again go to the 330 µF. Here, we have 0.4 volt drop. And with the 1000 µF, we have less than 0.1 volt, which is ok. So, again, if we use a 3.3 v regulator, a 1000 µF capacitor is a good choice.

Summarized, with the AMS1117 or the HT7333 voltage regulators, we need a beefy capacitor. Otherwise, we might experience crashes. If your other components allow, you could also use a 3.6-volt regulator instead of a 3.3 volt one.

The last step is now the deep sleep with the voltage regulator and a low loss 1000µF capacitor. At my first test, I measured around 80 µA, which is way too much. Investigations showed, that the reason for that was a simple 10k resistor on this small board, which bridges the input and the output pin of the regulator. It can be replaced by a 0-ohm resistor, if you do not want to use a voltage regulator. After removing this resistor, everything is ok and we see the expected less than 24 µA deep sleep current.

Summarized, the HT7333 has really a very low quiescent current of a few µA, and not, as some data sheets suggests, a few mA.

I hope, you got the necessary information on how you have to configure your ESP power supply for stability and low current consumption during deep sleep. Bye