LIMITING THE CURRENT OF YOUR STEPPER MOTOR

We talked earlier about improving the speed of our stepper motors by overdriving them, i.e. increasing the voltage above that of the manufacturers nameplate voltage, while it is fine to overdrive the motor and see it turn so much faster, with the gain in performance we create another problem for ourselves, if we overdrive the motor by twenty times then the current flowing through our coils will also be twenty times! This will definitely let the smoke out, so we need a way to limit the current through the motor.

Simple drives use either a low supply voltage to limit the current flowing; this is the most economical way but will limit the power that can be produced by the motor. Others use a resistor to limit the current; (often called a forcing resistor) this is inefficient but will allow for a higher drive voltage and consequently an improvement in motor performance. See the appendix on how to calculate the resistor values you need for a unipolar motor to increase its performance.

Sophisticated drives like the Geckodrive use a different method to achieve this, they switch the current to the coil on and when it reaches a preset value (the limit value that you set) they simply switch it off, the current will decay, wait a moment until a timer says OK and then switch it on again and so on. This is known as ‘chopping’ and it happens quite fast, the timer resets at around 22 000 times a second! No your multimeter will not be able to see that! Your oscilloscope will. This is a very energy efficient method of controlling the current as the motor will see the full supply voltage and the losses in the switch are minimal. Now you are thinking to yourself. “If the coil is switched on and off at around 25 kHz what happens when my step rate is faster than this? Will my coil actually be switched on?”

Good question and to answer your question, “Yes”, because Marriss the clever man that he is has connected the timer reset to the step signal, think about this, if you want the motor to move to the next step position you would want the current conditions to change anyhow. The wonders of modern science and a little company in California.

There are a few techniques for chopping the current in the drive as I mentioned earlier, switch it on and wait till it reaches it's preset value then switch it off and wait until the clock tells the device to switch it on again, this is probably the oldest and most common technique, more recently another technique has been adopted that is a bit more cunning, switch the coil on and wait until the current has reached it's preset value and then switch it off, instead of waiting for the clock to tell you when to switch it on again, wait until the current has dropped by a certain amount and then switch it on again, etc.

This sounds very good, “But,” you say, “if the current is switched off then our motor will not have any torque and it will stop!”

“No!” Remember the flywheel we spoke of earlier? Well due to the inductance of our coil the current will continue to flow but will diminish due to the resistance in the coil. (The flywheel will continue to turn but due to friction it will slow down). This way we are able to control the average current and inherently the power put to our system. It is uncommon to vary the current of a stepper motor system once we have finished setting the system up and optimised it unlike a DC motor where we may want to use the current to control the torque or run the motor in 'torque mode'. If you need a system where it is required to vary the torque it is unlikely you are using a stepper motor.

Gecko uses a 'current setting resistor' to set the current limiting for your motor, this seems easy enough but in the absence of the manufacturer's documents how will we know where to set the current?

"Easy! Trial and error." Very scientific isn't it? It is unlikely that you will do any damage to your system by running the motors with a torque lower than that required. Start with a low value, perhaps 500mA (4.7k) for small motors and 1A (10k) for larger motors. If your motor fails to turn, up the current until your system is reliable. Once your system is reliable then start to monitor the temperature of your motor, too hot and it is likely you might have to change to a larger motor as your system is under designed. If your motor remains cool then you have a well designed (perhaps over designed) system, there are some schools of thought that if your motor is not running at about 60C than you are not getting the most bang for your buck. Fine if you are looking to save a few cents but in most of our applications we are sensible and don't push the limits of our system.

There is a trade off between current and speed, while it is nice to increase the current and inherently the torque, (more torque means less chance of missed steps), remember that higher current will lead to larger field strengths in our coils, larger field strengths will take longer to build up and break down and so our maximum speeds will suffer. To determine the best compromise will require a great deal of trial and error or some very sophisticated equipment and some brainy people!

For most hobby applications we will probably never be faced with these extreme measures of extracting the maximum power from our system, reliability (no lost steps) is often more important to us than the maximum speeds and so we might never enter the envelope where these measures are necessary but it will benefit all of us to know of these things.

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