

## #13: True stepper closed loop motion – Can it be done?

I received an email message asking, “Is true ‘closed-loop’ stepper control really possible, and if so, what would be the advantages and disadvantages of doing it?”

Controlling any motor in a closed loop mode is possible. The cost of ensuring proper closed loop stepper operation is generally greater than ensuring proper operation in a motor designed to operate in a closed loop directly. Think about operating a simple AC motor at one RPM. Would this be possible, or even practical? In some cases it might be necessary, but the added cost for vector or other control must be factored in. It’s the same for closed loop stepper operation.

It’s usually not easy to adjust stepper phase current with respect to its angular position, but when this *is* done, the smart user will consider the amount of current that will be required to hold the stepper between its full step positions.

Microstepping sine wave amplifiers know how much phase current to apply to hold position, whether it’s moving or stationary. While a horizontal closed loop system requires zero current at a standstill, to maintain its angular position between full step detente positions, a stepper should require considerable current at a standstill.

Any loop system, closed or open, requires the user to know what type of motion is needed. The trajectory path algorithms are the heart of solving these problems.

Whether or not the system operates open or ‘closed’ loop has nothing to do with path generation. It has to do with the closeness-of-tracking requirement, or the following error. In other words, if the motor/ amplifier can maintain the required degree of actual control over the mechanics necessary to do whatever it is that needs to be done, then the system design is right.

A stepper system is designed to operate open loop. Open loop control simply means that there is no position or velocity feedback employed. It is a method of controlling a system by knowing it is working, rather than by measuring it is working correctly. This is not to say the device in question cannot operate in a closed loop mode, but why would you

want to? Ensuring the stepper has in fact stepped when told to is not considered closed loop control. In motion control systems, position is the primary performance factor. That means that knowing something has moved is not as critical as knowing how *far* it moved.

As a user of both open and closed loop systems, you’ll need to know how cost, size, speed, inertia changes (speed/torque curves), acceleration, etc. will all affect the selection of the motor style to be used. But if the ability of an ‘open’ loop stepper system can accurately and repeatedly control your device over its required range of operation, why, I ask, would you want to add cost to the system by using linear

scales, encoders, or other such position measurement devices. In addition, why would you want to add the time it will take or the skill it would require just to tune gain algorithms, etc.?

Gain algorithms in a closed loop system maintain the coordination of the desired trajectory path and the actual motion. They adjust for the difference between what the trajectory algorithms say the motion will do and what the actual motion is doing as it happens. The closed loop system takes the hoping-it-got-there worry out of the equation. But the reality of good design practice dictates that an open loop system will work just as well as the closed loop system if it is designed to operate within its ability. Since the stepper’s following error (the difference between where we want to be, and where we actually are) is zero, it is

actually easier to use when coordinating multiple axes in precision applications.

Really, the question of operating a stepper in closed loop fashion is not *can it be done*, but *should it be done*. Will there be any savings attached to the design? Will the customer appreciate it from a maintenance level? Will there be any special software, hardware, or customer talent required to do the job? Is it available from more than one source?

Doing something necessary is a given, but doing something simply to do it differently is foolish. The outcome is your credibility ■

**Controlling any motor in a closed loop mode is possible, even with the stepper. The added cost to ensure proper closed loop operation of a stepper is generally greater than using a motor designed to operate in closed loop directly.**



### About the Author:

In his more than two decades in the industry, **Chuck Raskin, PE, CMCS**, has contributed to many industry publications, including *Machine Design*, *Motion Control & PCIM*, and has recently finished the fifth edition of the *Designing with Motion Handbook*. Chuck is currently the manager of technical services for Technology 80 and a board member of the American Institute of Motion Engineers (AIME).