

TB050 (Rev1) - Long/Short Step in Incremental Movements

When jogging small increments, typically .0001" to .001", jog steps may produce an alternating series of long and short errors in the measured position, which is caused by mechanical imperfections. In these cases, the Digital Read-Out (DRO) of the control properly indicates the requested movement and the motor shaft movement (as indicated by absolute position in the PID Configuration table) verifies it, but the physical movement of the table does not agree. Obviously, there is lost motion

The lost motion can be found in "springy lash". Springy lash is a combination of high drag, starting friction, and windup between the motor shaft and the table. Springy lash is different than true mechanical lash because true mechanical lash will never spring back. Some possible mechanical components of the "spring" in springy lash are:

1. Ball screw bearing supports are flexing. (Check bearing supports with a dial indicator).
2. Yoke is flexing.
3. Ball screw itself is winding up.
4. Timing belt creep. Note that the belts themselves aren't stretching, but rather the belt teeth are actually deflecting against the pulley teeth. *Incorrect square tooth timing belts make it worse. See TB#003.

The mechanical problems listed above are only some of the possible parts of the observed long step, short step movement. The other factor in this situation is the high force required to initially move the table, or high drag forces. An indication of this contributing factor can be found by observing Kv1 values in the PID Configuration screen after a successful Autotune is performed. See TB# 045. Kv1 is proportional to the amount of torque (force) required to move the table at a slow jog rate, and thus an indicator of mechanical drag. Values for Kv1 that are above 20 are considered high drag, with Kv1 values exceeding 35 considered very high drag. Note that undersized motors and drives on a larger machine may give high Kv1 values, but this does not necessarily add to springy lash. Some possible causes of high drag or high force requirements are:

1. Lack of lubrication reaching the ways and/or ballscrews.
2. Incorrect gib adjustment.
3. General machined surface and ball screw mounting misalignments.
4. Oversized balls in the ball screw nut.
5. Too much tension in double nut adjustable ball screws.

The above mechanical problems combine to cause the short step, long step movement. Suppose at first there is no significant windup or rotational tension in the pulley, belt, and ballscrew system. The high drag required to initially move the table results in a small jog step being partially lost by the springy lash of the machine. A movement of the table occurs that is less than the jog increment requested. The belts and other mechanical parts are being twisted like a spring. On a subsequent jog increment, the high drag required to initially move the table results in a measured table distance greater than the requested jog increment due to unwinding of the springy forces followed by windup in the opposite direction when slight over travel occurs.

Modifications introduced in software release 5.27 attempt to counteract these mechanical imperfections to achieve more consistent table movement when jogging incrementally. Software, however, cannot perfectly remedy all mechanical imperfections. The only sure remedy for this problem is mechanical improvements to

reduce drag and/or springy lash.

Document History

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