

Dear A Tech...

"I recently bought a three year old, *gently* used CNC mill and discovered it's not repeatable and I'm having problems maintaining min. tolerances. Can a technician call me about fixing this? I'm getting conflicting reports from three service guys!" Thanks, *Desperate*.

Dear Desperate,

Position errors are very common and are typically caused by worn-out ballscrews being used as positioning devices, physical deviations in the machine being transferred to the finished part, or by encoder feed back errors.

Our technicians are routinely called out on these "mystery" types of problems. Experience has trained us to first analyze the type of error being reported in order to reduce the possibility of chasing erroneous causes. You stated in your email that your machine is not repeatable. Non repeatability can be caused by your encoder missing counts, ballscrew growth, or a control component failure. Since today's controls use stable solid state electronics with no moving parts, failures are rare. So, let's focus on the first two causes: encoder miscounts and ballscrew growth.

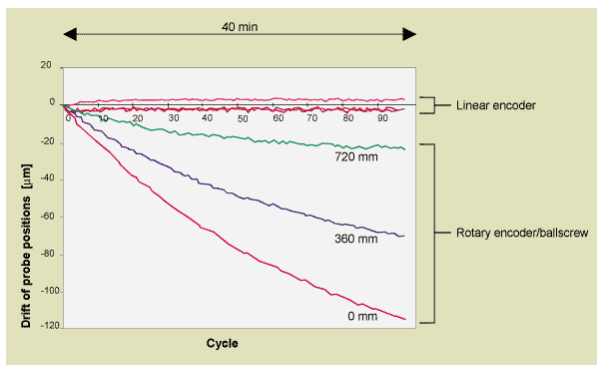
All CNC machines require sources of position feedback so that the control can maintain the axes' position. These position feedback devices come in the form of linear scales or rotary encoders (*sometimes interchangeably described as linear encoders or rotary scales*). You can use either rotary or linear feedback on a linear axis, as I assume you are describing.

A rotary encoder will mount to the end of the ballscrew, typically on the motor end, and count discrete increments as the ballscrew rotates. This form of feedback is relatively inexpensive and easy to install but allows mechanical errors to influence your machining process. You see, a rotary encoder mounted to the ballscrew will only track the position of the ballscrew, not the slide. Since the encoder is not monitoring the slide position, the control doesn't truly know where your part is, thus is unable to compensate for mechanical backlash or ballscrew growth.

As seen in the chart below, a ballscrew will grow as much as 120 microns (0.0047 inches) after machining for 40 minutes at 157in/min. I am sure you can see how your parts will change from batch to batch as you machine throughout the day. This type of non-repeatability is easily diagnosed by checking repeatability against an indicator. Simply attach an indicator to the spindle and attach a block of material at one end of the table. Position the indicator against the block and zero both the indicator and the control.

Now, back off the indicator and exercise the axis for about 20 minutes, then return to the indicator to check your zero position. Most ballscrews have at least one fixed end, so if you don't see any change in your zero position, move the block to the other end of the table and repeat the exercise. Once you have established movement of your zero position, let the machine rest for about 30-40 minutes to allow the ballscrew to return to its original temperature and size. You should see the indicator return to zero, confirming the thermal expansion theory. If this appears to be your cause of non-repeatability then don't worry, there's good news. Thermal expansion of the ballscrew can be controlled with the addition of linear scales to your machine.

If the indicator test performed above doesn't return to zero, then you most likely are experiencing lost encoder counts. Basically put, CNCs are dumb. A CNC knows that an inch equals a certain number of counts, so when you tell the machine to move 1 inch, it will continue to move in the commanded direction until the required number of counts is reached. For example, if an encoder produces 10,000 counts per



inch and you command your machine to move 0.5000 inches, then the machine will move until it reaches 5000 counts. Let's say that the scale has a dirty spot causing it to miss 50 counts. Well, the machine will still move until it reaches 5000 counts, but in this case, it will go 50 counts too far resulting in a position of 0.5050 inches.

Most encoders and scales used on CNC machines today are optical because of their high accuracy and repeatability. Unfortunately, optics are susceptible to contamination and aging which cause missed counts. Since you mentioned that the machine is only three years old, I don't suspect aging in this case. Therefore, if you are experiencing non repeatability that is not caused by thermal growth as described above, you most likely have a dirty or misaligned scale. Our technicians are available to assist you in every aspect of this repair from telephone support to complete removal and repair of the scale.

I know this is a lot of information to understand all at once, so I will call you shortly to discuss your specific needs in more detail.

Sincerely,

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