A Precision Electronic Edge Finder Probe, Version 1.1

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An edge finder probe is used to detect a vertical reference surface relative to the mill's spindle's Center Of Rotation (COR). Knowing this location, any end mill of known diameter can be installed with its cutting edge location defined. This is essential information when performing Computer Numeric Control (CNC) machining.

I own a Tormach TTS tool holder system. Here is one for an end mill.

The TTS adapter collet fits in my R8 spindle and holds the shank of a TTS tool holder. This is a precision tool.

With a length of ¾ inch drill rod installed, my Dial Test Indicator showed a deviation from the Z-axis of less than 0.0005 inches over 3 inches. However, I did measure a Total Indicated Runout (TIR) of 0.005 inches. This is likely due to my mill and not this adapter.

If I just installed a length of this drill rod, it would make a poor probe due to this TIR. However, it is a great start.

My probe[2] uses some of this ¾ inch drill rod. I faced the end on my lathe and sawed off about ½ inch of it. Then I faced both the new end and the rough-cut face of the puck. These faces had a mirror finish thanks to my Diamond Tool Holder.

I drilled and tapped the shank 8-32 to a depth of about ½ inch. The puck was drilled 3/16 drill (0.1875 inches).

I secured the puck to the shank with a Belleville washer and a screw. This gave me plenty of friction between the puck and the shank without locking them up.

A standard clearance hole for 8-32 is 0.1695 inches in diameter. By using the 3/16 drill, the puck can slide at least ± 0.009 inches. That is plenty of room to compensate for my TIR.

I aligned the probe by first installing it into my spindle with the TTS adapter. Next, I placed my finger Dial Test Indicator (DTI) on the puck. By rotating the spindle, I could see the TIR.

I first put red lines, 180 degrees apart on the end of the shank. Green lines were offset 90 degrees from them. With a red line at the DTI, I zeroed the indicator. Then I turned the spindle to the other red line and read the change. Finally, I divided this number by 2.

Due to the smooth mating surfaces, it was easy to push on the puck and move it 0.0005 inches at a time. I rotated the spindle such that pushing on the side opposite the DTI raised the reading by the value just calculated. Going between red lines, I quickly got the change in readings to be less than 0.0005 inches.

For example, say the first red line gave a reading of 7.5 thou and the second red line showed 18. The difference is 10.5. dividing by 2 gives me 5.25. I rotated the

[2] I can get away with a non-insulated probe because I detect touchdown by looking at the resulting tiny change in resistance.

spindle to the side that gives me 7.5 and push the puck until it reads 12.75. The other red line should read the same. If not, I repeated the procedure.

I then performed this alignment on the green lines. A final check involved turning the spindle 360 degrees to verify the TIR was within ± 0.0005 inches. There was no value in getting better due to observed play in my spindle bearings. I used to have less play in these bearings but they got too hot while running.

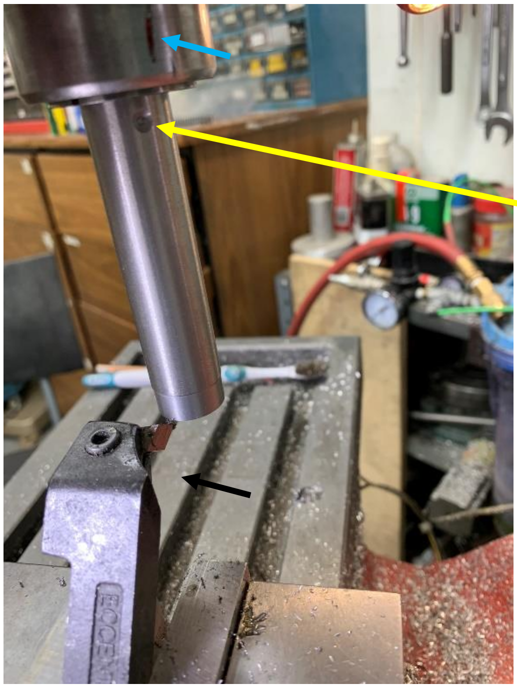
With alignment complete, I added dots of red paint across the shank/puck gaps. They will tell me if excessive side force was applied that shifted the puck. So far, so good.

There is one more red line. The spindle has a pin inside of it that engages with the adapter. I have a red line on the outside of the spindle at this location. I align this red line with the red line on the shank. This minimizes any TIR in the shank and adapter.

Testing

I touched down on a reference surface along the X-axis and the machine position was 4.9678 inches. After backing away, I rotated the probe 180 degrees and fed back in again to touchdown. This time I read 4.9669 inches. This change of 0.0009 inches is the total TIR which is consistent with the DTI measurement of ± 0.0005 inches.

After using this probe for a while, I discovered that the puck had shifted slightly. Although easy to recalibrate, I lost trust in the tool. Time for a new design that can't be knocked out of calibration.



This time, I decided to put my lathe cutter in my mill vise (black arrow) and machine the reference surface in place. I drilled a shallow hole in the side of some ¾ inch drill rod about 2 inches from one end and filled it with red paint. This dot lines up with an engraved line (blue arrow) that is aligned with a pin inside the spindle.

I then took a light cut over the bottom ½ inch.

I measured the resulting diameter and found 0.72655 inches. This means that, on average, I removed about 0.012 inches from the radius.

To use the probe, I align the dot with the line on my spindle. This removes the spindle and collet runout.

Testing

My first test was of runout. This measures spindle bearing play. There should be no error from static runout because the reference surface was machined in place.

Using my Electronic Edge Finder, I touched down on the side of my 1-2-3 block and set the CNC's readout on the X axis.

Red dot orientation	CNC readout at touchdown, inches
To front	0.3632
To right	0.3639
To back	0.3628
To left	0.3636

The average is 0.3634 but more importantly, the variation is ± 0.0006 inches. This compares well with the data from my first design. It is due to bearing play.

The second test involves measuring a known distance. These 1-2-3 blocks are precision ground. I touch down on the left end of the block and noted X equals -0.3633 inches. I then raised the probe slightly and moved over to the other end of the block. At touchdown, I read 1.6380 inches. This is a change of 2.0013 inches.

I repeated the test and read -0.3628 and 1.6377, a change of 2.0005 inches. This is 0.0008 inches less than the first pass. Given the above uncertainty of ± 0.0006 inches per reading, this is within the expected range of ± 0.0012.

Note that I fed the probe into the reference surface at both ends of the block. This avoids the error due to backlash.

Conclusion: the machined-in-place probe is as accurate as the adjustable probe. The benefit of this new design is that it cannot be pushed out of alignment. A minor disadvantage is that the diameter is not a standard value. Since this number is stored in my CNC software, the added digits are only typed in once.

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