

Improving a Harbor Freight® 6" Digital Caliper, version 1

By R. G. Sparber

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Scope

This article explains how I took the caliper apart and improved its "fit and finish".

Background

I have bought many Harbor Freight 6" Digital Calipers over the years. They worked fine as digital calipers but were also modified for various other projects. At around \$12 each, they were an amazingly good deal. The latest version of this caliper has changed dramatically in a clear effort to reduce manufacturing costs.

Along the way, they also changed how the caliper behaves after power down. Previous models retained their position when the display blanked. Current drain in this blank display state was not significantly different from when the caliper was in full operation.

With this new model, the display always shows 0.000 when it comes back on. The expectation is that the battery will last longer but that has yet to be proven. Given

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this new power down behavior, it is possible that the data format out of the SPI port has also changed.

Unboxed



When the shrink wrap is removed and the cardboard sleeve discarded, are able to open the lid on the case. The caliper you find has one battery already installed plus a spare. I have often found the installed battery to be dead so the extra one is appreciated. These batteries are alkaline and have a much shorter life than the silver oxide variety.

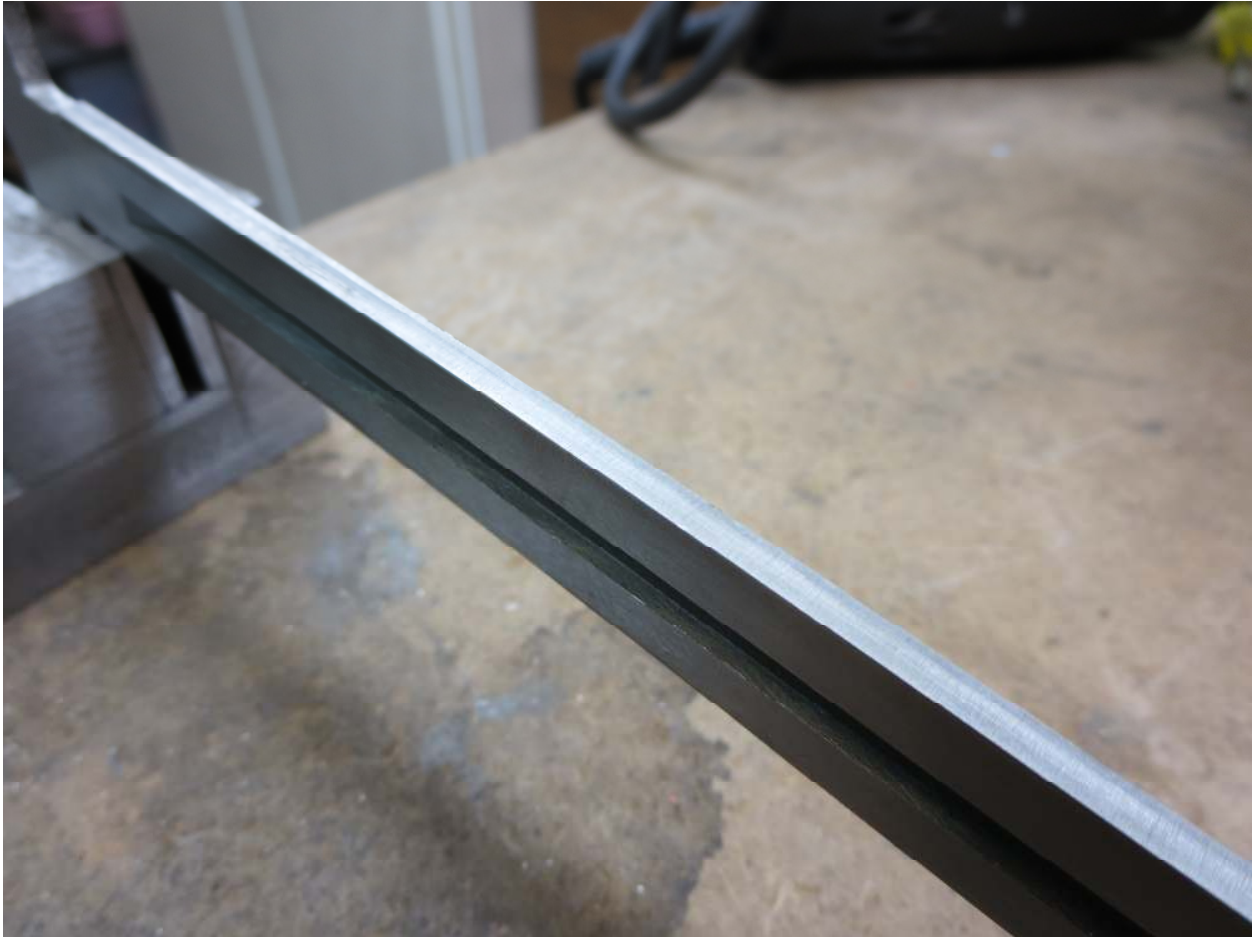


The installed battery was still good so after pressing the OFF/ON button and then the inch/mm button, I saw inches on the display.

The SPI data port is under this sliding door.

The battery is under this sliding door.

Fit and Finish



This is a close up view of the edge of the body. Notice the cross grind marks. As the slider moves along this edge, it must ride over these marks. This is the main reason for the rough feel of the instrument. It sounds and feels a bit like dragging a rake across a slab of concrete. Fortunately, this surface finish can be improved using commonly found tools. This does require disassembly of the caliper.

Dismantling the Caliper



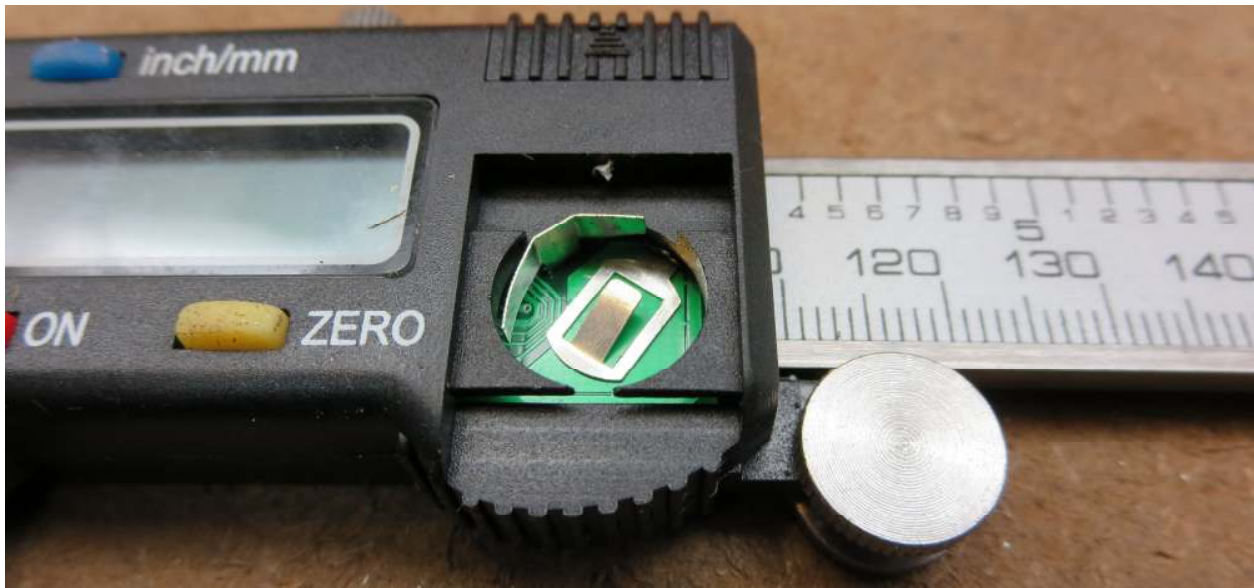
Turning the caliper over, you see this rather colorful label.



Oh well, not as nice now. Digging around I have uncovered the four screws that hold the body together. Once apart, you can soak the rest of this label off.



Remove the battery before performing further disassembly. We don't want to short anything out and blow the circuit.

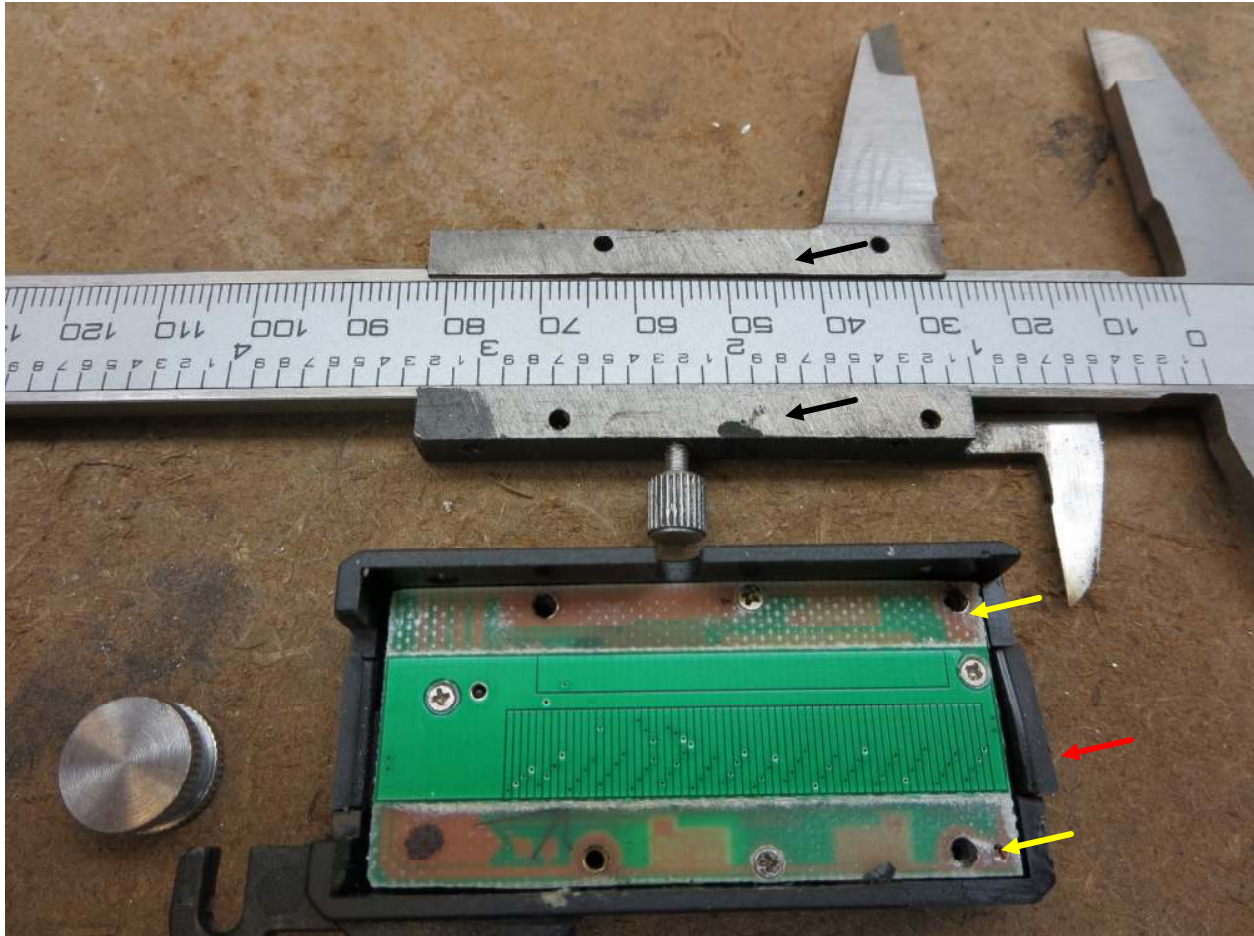




Using a small Phillips head screwdriver, I removed the bolt in the lower left corner. This bolt threads into a bit of metal which secures the thumb wheel support.

The other three screws are designed to cut threads into plastic.

Be sure that thumb screw (red arrow) at top center is backed all the way out. If screwed in, it will lock the slider to the body.



The plastic shell with attached electronics is a snug fit to the metal slider. Hold the slider's body in one hand and pull the shell straight up.

The thumb wheel is captured between its support and the body so will just fall out. One or both of the little plastic wipers may also fall out. Here you see the left wiper remained in place but the right one (red arrow) partially lifted out.

The big surprise to me is what you do not see here. All past versions of this caliper had two thin strips of phosphorus bronze. These strips rested in the horizontal recesses (yellow arrows) of the circuit board and seemed to both act as wear pads and one plate of a capacitor formed with the etched pattern seen in the center of the circuit board.

These phosphorus bronze strips have been replaced by machined features (black arrows). These features are part of the slider and are very rough on all surfaces. They are also not adjustable.



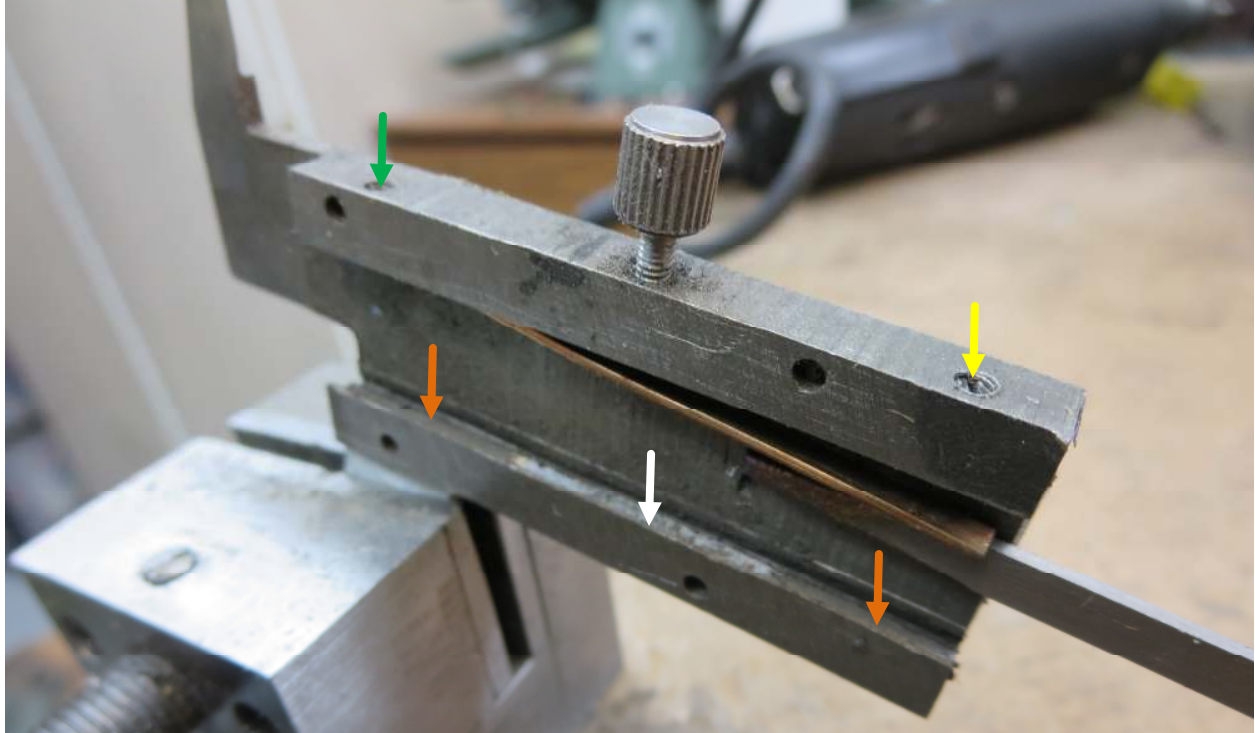
Before trying to remove the slider, the clamp on the end of the body must be disassembled.



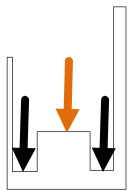
With the two screws removed, the top plate comes off. It is more like a washer and spreads the clamping force over a large area. This is necessary because under that silvery label is an etched strip that is fairly delicate.

When the two screws come out, the plate on the back is free. This plate is tapped so no nuts are needed. Remember that the narrow side of this plate points towards the body. If mounted so it points out the end, depth measurements will not work right.

You can now move the slider off of the body.



Here you see the bare metal frame of the slider. A phosphor bronze strip attaches to the top side. (Poorly) machined reference surfaces (orange arrows) can be seen at the bottom. Between these surfaces the metal is roughly cut away so it does not contact the edge of the body (white arrow).



Flanking these reference surfaces are cuts (black arrows).

The intent here is that the bottom edge of the body slides on the bottom reference surfaces. The phosphor bronze strip applies pressure to the top edge.



This strip is bowed so only the center portion

contacts the body. Tightening that fluted screw applies a locking force. The hole on the left engages the screw (green arrow above) nearest the jaws. The other screw (black arrow above) tightens the strip against the body. The screw was backed out all the way and the slider was snug.

I sprayed alcohol into the frame and a surprising amount of metal shavings came out. The contact surfaces is rough milled and not ground.

Improving the Fit and Finish



My first task was to smooth the inside of the slider. I used a piece of steel with a lip bent into it and some fine emery cloth.

The lip enables me to get to that set of lower reference surfaces.



By sliding the metal and emery cloth back and forth, I was able to remove much of the roughness. It is better, mind you, not great.

The peaks come right off but it takes more effort as you must grind away more material.



Using Hi-Spot[®], I coated one edge of the body and placed it down on my surface plate. The resulting variation in blue tells me how far from flat is the edge. I did not see any place where the edge had no blue. So my conclusion is that this edge, on average, is rather close to true. However, it is still rough.

Using a fine stone, I was able to smooth both edges of the body a lot.



As a final smoothing operation, I used some Clovis[®] 500 grit lapping compound on the body and slider.

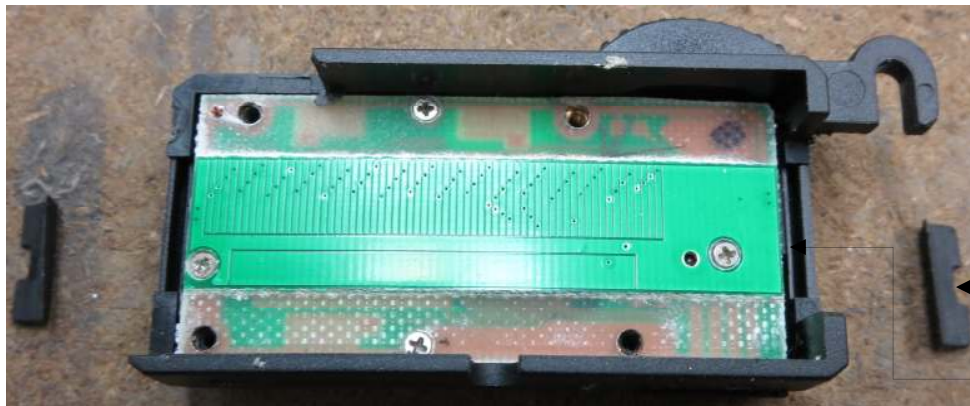
I then moved the slider back and forth on the full length of the body 100 times. The parts were then separated and alcohol used to fully remove all compound.

In hindsight, it would have been better to put more effort into smoothing the slider's reference surfaces because this lapping did not help a lot.

Final Assembly



The slider and body are now ready for reassembly.



The two wipers have been removed here. Note the square notch in each one.

This notch feeds down the square hole.



Here you see the wipers installed.



I pressed the plastic case down on the metal slider body and then moved the slider to the end of the body. It is then possible to install the thumb wheel.



As the end of the body moves to the right with respect to the slider, the thumb wheel will be captured.



The three screws that cut into the plastic have been installed and I'm about to install the one bolt.



As a final step, I used a very tiny amount of instrument oil on all sliding surfaces. One or two drops is plenty. When done, wipe the caliper down with a clean/dry cloth to remove excess oil.

The resulting caliper does slide smoother. How smooth depends on the effort expended stoning various surfaces.

Accuracy Check

I did the following spot check of caliper accuracy. Spacer blocks were used that are ± 0.0001 ". Before each reading, I closed the jaws to verify the reading was zero. In about one third of the cases, I had to reset to zero. Mostly the zero point was off by ± 0.0005 ".

Spacer Block	Caliper reading
0.100	0.101
.500	.501
.900	.901
1.000	1.001
1.000+1.000	2.0015
1.000+1.000+.900	2.9025

The last two readings are out of spec as defined on page 3 of the Operating Instructions. The accuracy is slightly poorer than my last digital caliper from Harbor Freight.

I welcome your comments and questions.

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