American Lutherie 149 (2023), p. 58-59

Quick-and-Dirty Magnetic Thickness Gauge

by Jon Sevy

I **RECENTLY HAD A NEED** to check the thickness of the sides in an acoustic guitar body after sanding out some lumps to see if I might want to install some reinforcement backing in the thin spots. Calipers are clearly not going to work deep inside a guitar body, so I needed some alternate approach.

There are commercially available magnetic thickness gauges that can provide this sort of "blind" thickness measurement, using a steel ball on the inside and a detector connected to a digital display on the outside. But these are quite expensive, costing hundreds to thousands of dollars, so not very practical for occasional small-shop use. There are also inexpensive magnetic automotive paint thickness gauges that look a bit like a ballpoint pen with a magnetic tip; you put the tip against the paint on a steel fender, and pull back until the magnetic tip releases from the surface, at which point an indicator on the device tells you the paint thickness based on how hard it was to pull the indicator off the surface. But these are designed for the typical thicknesses found in automotive paints, maxing out at around 0.020″, and thus won't even register for typical guitar side thicknesses of 0.080″–0.100″. And of course there are digital versions today, but these have similar range restrictions.

There are some beautiful shop-made gauges, described by Mike Doolin in *AL#109* and Alain Bieber in *AL#96*. These are specifically targeted to lutherie use, covering the range of thicknesses of interest to luthiers. They use readily available materials, but do require some time and effort to assemble. One of these would have worked perfectly for my application, but unfortunately I hadn't built either. I was looking for a quick-and-dirty way to estimate the side thickness without a detour into building a gauge (although Doolin's is definitely on my to-do list). So I looked at finding a simpler way to get a rough measurement.

Photo 1*. Magnet, scale, and backing rod.*

The basic principle of all of these devices uses the force of attraction between two magnets (or a magnet and a piece of steel) on either side of the material to be measured, using the fact that the further apart two magnets are the less their force of attraction. The thicker the material separating the magnets, the less pull they will have on each other; by measuring the force it takes to pull them apart and calibrating it for different thicknesses of material, we can create a magnetic thickness meter. The force can be measured in various ways; some gauges use a spring whose stretch is proportional to the force, while Doolin's uses an ingenious balanced set of magnets and a dial indicator.

I used an inexpensive digital fish scale that I had on hand that reads from 0.1 lbs to 110 lbs. For the magnet, I used a MagSwitch MagJig 95 switchable magnetic clamp with a wire loop to hook the scale, and for the backing a 1¾″ length of ⅜″ diameter steel rod **(Photo 1)**. The main requirement is to select a magnet and steel backing with a pull that's strong enough to register on the scale when separated by the thicknesses of interest (about 0.040″ to 0.100″).

The next step is to calibrate the gauge. This involves measuring the force of attraction using plates of various known thicknesses, in my case pieces of scrap from 0.037″ to 0.115″. Each plate is clamped onto spacers on the workbench, with the magnet on top and the steel backing rod underneath; the magnet holds the rod up onto the underside of the plate (it's not visible in **Photo 2)**. The scale is attached to the loop on the magnet, and slowly pulled upward, watching the digital force value increase until the magnet pulls away from the plate and the steel rod drops to the workbench.

The force at which the release occurs is recorded, and the process repeated; you need to make multiple measurements at each thickness to account for variation in the steadiness of your pull. I took five measurements at each thickness, and used the average of these as the release force for that thickness. The result is a table giving force versus thickness for the sample plates used for calibration. I put the values into a spreadsheet (see **Table)** and plotted a trend line that graphically showed the relationship between the release force and the plate thickness, but you really only need to look at the numbers to get rough estimates of thickness by interpolating between the values.

The gauge can now be used to measure the force on a piece of unknown thickness. I put the steel rod inside the guitar body at the spot on the side whose thickness I wanted to measure, and placed the magnet opposite the rod on the outside of the body. One nice feature was that the magnet was strong enough that it held the steel bar and itself in place on the side, freeing up a hand to attach the scale to the loop. Pulling the magnet until the rod released, I recorded the force at which the release occurred **(Photo 3)**. I repeated this seven times to account for variation in my pulling prowess, and computed the average of the force values. Using this force value and the table of calibration values (or the corresponding graph in the spreadsheet), I could then estimate the corresponding thickness of the side at that point. One thing to note is that I calibrated pulling vertically but measured pulling horizontally. Since the weight of the magnet is added when pulling vertically but not horizontally, the tare on the scale needs to be adjusted for the magnet weight when calibrating or measuring vertically.

The table and graph indicated that for the force I measured, averaged at 3.50 lbs., the corresponding thickness was about 0.063″. That's considerably thinner than I usually use for a full-sized guitar side (0.090″–0.100″), so I added a reinforcement patch at the location of the thin spot to minimize the chance of a crack developing.

This technique can be used just about anywhere to measure plate thicknesses, as long as you have access to get the steel backing rod opposite the magnet — easy with a classical or steel-string acoustic with a round soundhole, probably not very feasible for an *f*-hole arched top. I tried using a steel ball instead of the rod, which would allow access into tighter spaces, but the pull wasn't strong enough with my magnet to register reliably on the scale.

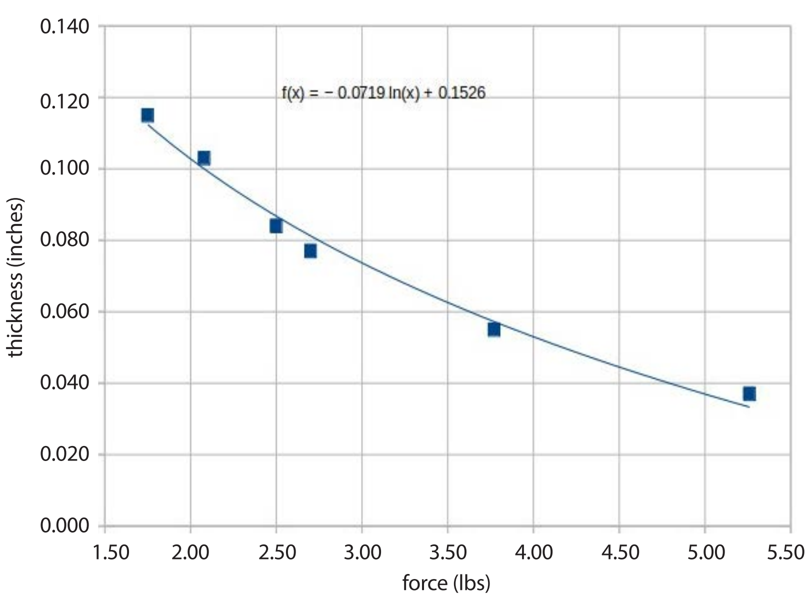
One caveat is to be careful about where the steel rod will drop when the magnet pulls off; the heavy rod could leave a dent in soft materials like the underside of a guitar top, so a protective rag is a good idea. The type of wood doesn't have an effect, since wood has no magnetic properties, so this will work on everything from balsa to lignum vitae; in fact, it can be used to measure the thickness through any non-magnetic material such as plastic or shell.

This is truly a DIY thickness meter, in that you'll have to calibrate for yourself. The force value for a given thickness depends on the magnet you're using and the size of the steel backing rod. And it's pretty inexpensive; digital fish scales that go up to 110 lbs cost about $10–$15 on Amazon, and the MagSwitch MagJig 95 is around $35. Both of these have lots of other uses, so they're good investments anyway.

Photo 2. *Calibration. The steel rod is not visible beneath the plate.*

Photo 3. *Measuring release force for a guitar side. The steel rod is inside the body.*

Note that it's important to make repeated measurements and average as described above to get reasonable accuracy. You can assess the accuracy of the gauge using some test plates of known thickness; I did this, and was surprised to find that the predictions were accurate to just plus or minus a few thousandths. You don't need to go to the trouble of graphing on a spreadsheet as I did — you can use the table of the thicknesses and their (averaged) release force values for the calibration pieces, and interpolate in between the values in the table for the measurement. Or you could even skip the calibration altogether — measure the release force for the part whose thickness you want to measure (the guitar side in my case), and then use trial and error with scrap pieces and a thickness sander to find one which gives about the same release force, and you'll have found your thickness.



Thickness (inches)	Force (lbs)
0.115	1.75
0.103	2.08
0.084	2.50
0.077	2.70
0.055	3.77
0.037	5.26
	Side 1 forces
	3.38
	3.47
	3.37
	3.95
	3.58
	3.40
	3.37
average:	3.50

Table. *Force vs thickness values, graph, and sample measurements.*