Methods of Measurement

Unofficial guide for measurable items in Finning @ Surrey Warehouse

Author: Average Rob Morrison Enjoyer

Editor: Weakest Disciple of Sarai Sensei

Introduction: This short document aims to impart methods of measurement for parts that require measurements that I found over the course of my tenure here. The methods I outline in the following sections offer a balance and tradeoffs between ease-of-use and exactness. Of course, it's nearly impossible and impractical to try to find the exact number for really long cut pieces no matter what method you use — the goal is to try to minimize the error and get close to the real number as much as possible.

The following list is ordered from the most practical and easy to use (ones which I used most often) to the more exact but more computational difficult methods.

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1 Counting Scale

This is the method I would recommend using for **90%** of cases requiring measurement — it has high accuracy (given a good sample) and is great when you have messy coils. I would recommend using the other methods to verify the measurement made by the scale.

Use the packaged quantity length as your sample if possible, otherwise try to find the easiest to measure cut piece and use that as the sample. Refer to the `How to use the scale` document for guidance on how to operate the scale.

2 Fold in half method

Fairly straightforward: fold a piece in half to make it easier to measure, measure it, then multiple by 2 to get the original length. I wouldn't recommend folding it more than a half since each additional fold increases the "arc" at the end which adds error and makes it harder to measure.

A worthwhile mention in this category is using references like the cells in Binning that are 3ft wide as a ruler to measure the length of a medium sized coil. Find how many cells the coil spans and multiply by 3ft to get the total length.

let l be the total length
let c be the number of cells

$$l = c \cdot 3ft$$

3 Averaged circular coil method

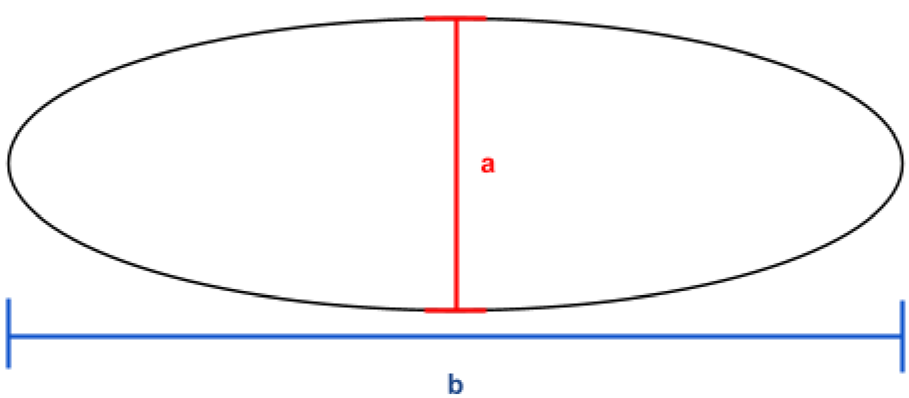
Use this method when there isn't any packaged quantity and the cut length is large. The first step is to find the average diameter of the coil which is around halfway between the innermost and outermost loops (you can ignore this step if the thickness of the coil/wire is small). Then use the following formula to find the total length:

let $\hat{d}$ be the average diameter
let n be the number of loops

$$l = \pi \cdot \hat{d} \cdot n$$
$$\pi = 3.14159$$

Tip: Often the ends of the coil make it so that there aren't perfect loops for the innermost and outermost loops. Which is why I leave n as a decimal number to ballpark how many complete loops the two ends would make if they were rolled out. Ex. if there are 6 complete loops between the innermost and outermost loops, and I think that the innermost and outermost combined would make around 0.75 of a complete loop, I would set n = 6.75 in the formula above.

4 Averaged elliptical coil method



This method is basically the same as 3, but instead of a circular coil we have something like an ellipse (as shown above). So find the average diameter of the ellipse by:

$$\hat{d} = \frac{(a + b)}{2}$$

Other than the modification to $\hat{d}$ everything else remains the same:

$$l = \pi \cdot \hat{d} \cdot n$$

Note: This is ***not the exact*** arc length of an ellipse. Unlike a circle which has an exact arc length of 2π * radius or π*diameter, finding the exact arc length of an ellipse requires a bit of calculus explored in the next few sections.

5 Exact circular coil method

Now you have ventured into the dark side of the measuring world, with the goal of having higher accuracy even if it means doing more math. This method works well with coils with flat sides that wrap nicely together with almost zero gap between each loop (which is the case for many CAT products we have). Start with measuring the innermost loop diameter and thickness of the coil. Then use this formula to find the total length:

let d be the innermost loop diameter
let k be the integer number of loops
let t be the thickness of coil

$$l = \pi \cdot \sum_{n=0}^{k-1} (d + 2tn)$$

6 Exact elliptical coil method

This is the same concept as 5, but with elliptical coils and needs a little bit of calculus. To get the theoretically exact amount first calculate the arc length of an ellipse (refer to diagram from method 4):

let r be the radial length
let θ be the angle (in radians) of the radial arm from the x-axis
let s be the total arc length

$$r^2 = x^2 + y^2 \text{ (Pythagorian Theorem)}$$

$$\therefore dr = \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}\, d\theta$$

and x and y can be parameterized as :

$$x(\theta) = b\cos(\theta)$$
$$y(\theta) = a\sin(\theta)$$

$$s = \int_0^{2\pi} \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}\, d\theta$$

Now to generalize it for k integer number of loops:

$$l = \sum_{n=0}^{k-1} \int_0^{2\pi} \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2}\, d\theta$$

$$x(\theta) = (b + 2tn)\cos(\theta)$$
$$y(\theta) = (a + 2tn)\sin(\theta)$$