Using the Three-Wire Method to Measure Threads

The pitch diameter of a threaded object can't be measured directly except with specialized thread micrometers. But using three wires of the same known diameter, the thread pitch can be measured with a standard micrometer.

Chris' Tip: This entire discussion is about 60° threads. Pee Dee Thread Measuring Wires can be used to measure other threads (and tables for Acme threads are included with the Pee Dee Thread Measuring Wires), but it changes the formulas and constants. We are also talking about threads with a small lead angle, so don't try to use these formulas with double-start threads. *Machinery's Handbook* has information on using thread measuring wires on many kinds of threads.

Making the Measurement

Let's start by saying that it can be a little tricky handling three wires and a micrometer all at the same time. There are several tricks of the trade that can make it easier but learning to make the measurement without "accessories" can ultimately be faster and more accurate.

Here's the process for taking a measurement.

1. Put a shop towel under the work area to catch the wires you drop.

2. Based on the pitch of the thread you are measuring, use the table below to select the proper set of thread measuring wires.

3. Adjust your micrometer to about 0.010" larger than you expect your measurement to be.

4. Put two wires in adjacent V's on the bottom of the part. Use the fixed anvil of the micrometer to hold them in place.

5. Now on the top of the part, slip the third wire into a V under the movable anvil of the micrometer.

6. Take your micrometer measurement.

This process sounds harder than it is. I was successful on my second try.

Some people use grease on the threads, rubber bands or modeling clay over the ends of the wires. Any of these tricks will take longer than the method above, and they all can affect the accuracy of the measurement.

Calculating the Pitch Diameter

Now that you have your measurement, it's a simple process to find the pitch diameter.

1. Find the Constant for the thread pitch you are measuring from the chart below. (Note that a compact version of this chart is included with the Pee Dee Thread Measuring Wires.)

2. Subtract the constant from the measured value.

Here's the formula:

E is the pitch diameter you are trying to find

M is the measurement you took

Const is the Constant value from the chart.

$E = M - Const$

The photo above is measuring a piece of ½"–13 threaded rod. The micrometer reads 0.5112". So the formula is:

$E = M - Const$

$E = 0.5112" - 0.06838$

$E = 0.4428"$

A ½"–13 class 2A thread (commonly used for fasteners) should be between 0.4485" and 0.4435", but it is not surprising that threaded rod is somewhat small.

Chris' Tip: You can find the pitch diameter of unified and metric screw threads in *Machinery's Handbook* and also in *Machineries Handbook Pocket Companion*. Both of these books are available from LittleMachineShop.com

Wire Sizes and Constants

TPI	Wire Size	Const		TPI	Wire Size	Const
48	0.018	0.03596		11.5	0.055	0.08969
44	0.018	0.03432		11	0.055	0.08627
40	0.018	0.03235		10	0.055	0.07840
36	0.018	0.02994		9	0.063	0.09277
32	0.024	0.04494		8	0.072	0.10775
28	0.024	0.04107		7.5	0.081	0.12753
27	0.024	0.03992		7	0.081	0.11928
24	0.029	0.05092		6	0.092	0.13166
20	0.029	0.04370		5.5	0.108	0.16654
18	0.032	0.04789		5	0.120	0.18679
16	0.040	0.06587		4.5	0.127	0.18855
14	0.040	0.05814		4	0.143	0.21249
13	0.045	0.06838		3.5	0.185	0.30756
12	0.055	0.09283		3	0.185	0.26632

How Does This Work?

In theory, you are measuring with wires of a known diameter that contact the threaded part on the pitch line. As with most things in life, actual practice involves compromises.
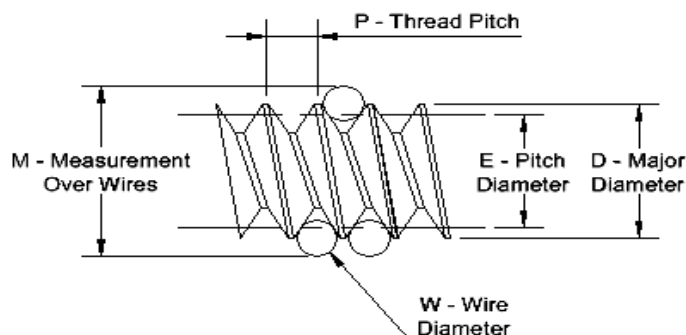
There are three formulas for calculating appropriate wire sizes:

Smallest wire diameter = 0.56 × Pitch

Largest wire diameter = 0.90 × Pitch

Diameter for pitch-line contact = 0.57735 × Pitch

If you do the math, you will find that all the suggested wires in the table above are between the smallest and largest values.

The thread pitch for an American National Standard Unified 60° thread is:

E = M + 0.86603P – 3W

Notice that if we know the pitch (P) and the wire diameter (W), then for any particular pitch, the formula reduces to:

E = M – Const

where Const is a constant for a particular pitch and wire size combination. These are the constants given in the table above.

Take a look at the first formula for a moment. The value 0.86603 is a constant because we are only considering 60° threads. It encapsulates some trigonometry involving the thread angle.

The 3W term is the interesting one. It highlights the fact that your thread measuring wires must be the correct size. Any error in the wires is magnified three times. There is more to consider than wire diameter. Bent, distorted, or dirty wires will also affect the measurement. (Rubber bands, anyone?)

Metric Threads

Metric threads are also 60° threads so these formulas work just as well with them. The following table shows the wires and constants for common metric threads. These constants assume you are working in millimeters, not inches.

Pitch	Wire Size	Const
0.5	0.018	0.93859
0.6	0.018	0.85198
0.7	0.018	0.76538
0.75	0.024	1.17928
0.8	0.024	1.13598
1	0.029	1.34377
1.25	0.032	1.35586
1.5	0.040	1.74896
1.75	0.040	1.53245
2	0.045	1.69694
2.5	0.063	2.63553
3	0.072	2.88831
3.5	0.081	3.14110
4	0.092	3.54628
4.5	0.108	4.33247
5	0.120	4.81385
5.5	0.127	4.91424
6	0.143	5.70042
8	0.185	7.16876