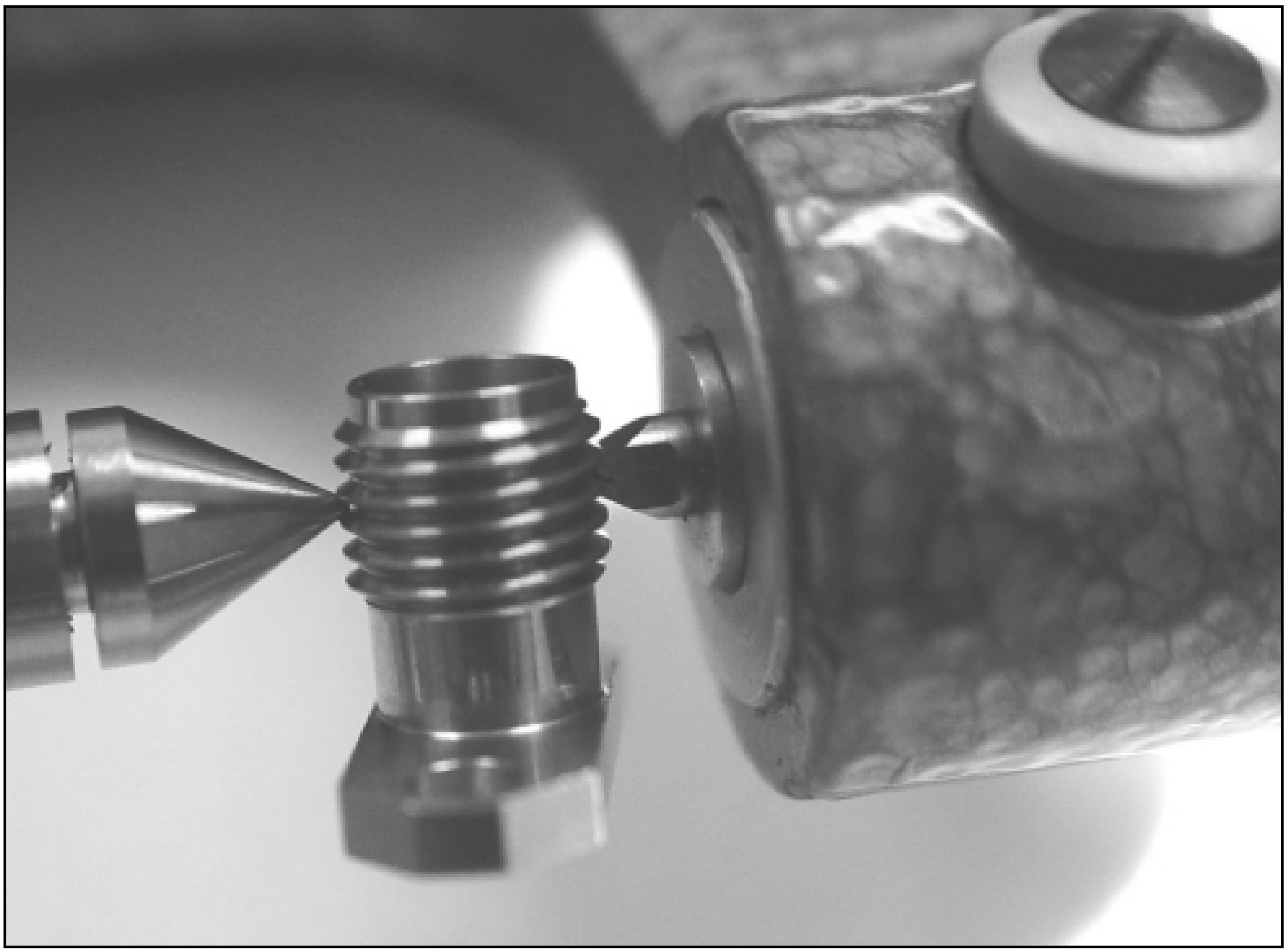
Microwave Connector Thread Gaging

Technical Note



When making a microwave connection with a coaxial connector, a good ground connection must be achieved. If not, poor return loss will result. If the ground connection is loose, performance will be inconsistent and will cause intermittent performance problems. Connector threads play a crucial role in achieving a good ground connection – they must be made properly in order to achieve good consistent results.

It has come to our attention that there may be confusion regarding the measurement of connector threads to determine if they are properly made. The intention of this note is to clarify methods used to measure threads and to define some terms used in thread measurement.

This simplified diagram shows the major features of threads that are important for this discussion

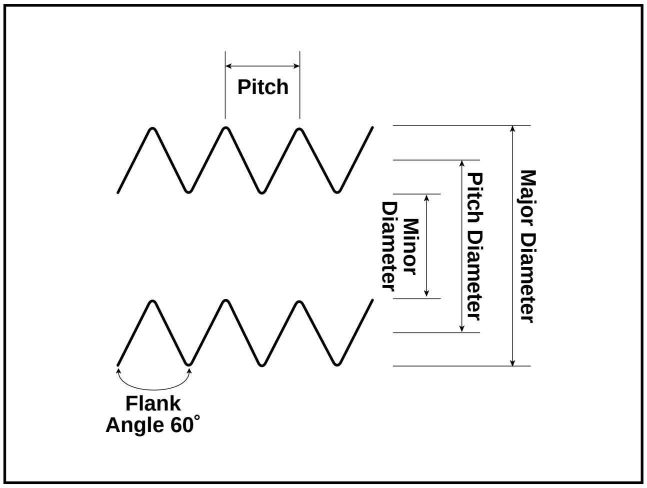


Figure 1. *Thread definition*

For the threads of a female K connector, the pitch diameter of a perfectly made thread is 0.2311 inches (5.870 mm) while the minimum pitch diameter is 0.2280 inches (5.791 mm). The correct flank angle is 60°. The major diameter of the $^1/_4$-36 thread used on the K connector is 0.250 inches (6.35 mm) and the minor diameter is designed to be 0.1885 inches (4.788 mm) while the correct pitch is 0.0278 inches (0.706 mm.)

If the female thread pitch diameter is too small, it may not be possible to torque the nut to 8 in-oz or the connector may tilt as the threads are tightened. Figure 2 shows what may occur.

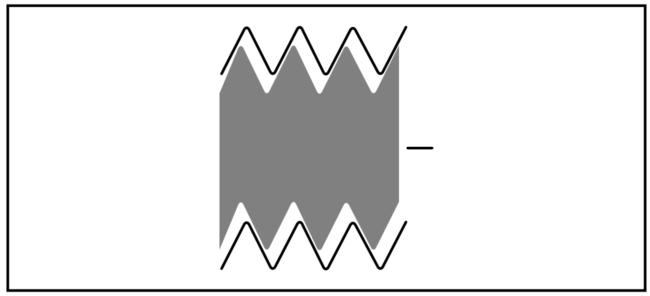


Figure 2. *Undersized Threads (exaggerated a bit)*

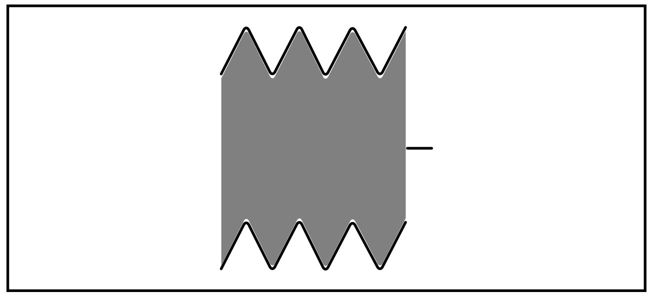


Figure 3. *Properly sized Threads*

If the pitch diameter is too large, the specified torque specification may be reached before the center pin is properly engaged, resulting in poor return loss due to excessively large pin gap. Remember that housing threads can also cause problems tightening to the proper torque.

Thread Measurements

There are two primary tools used to measure threads.

Go-No Go Gages

The first and easiest to use are Go-No Go gages. The type for external threads look similar to die used to thread rods. They come in pairs, the “Go gage” and the “No-Go gage.” The Go gage should thread on easily while the No-Go gage, whose threads are slightly smaller, should jam after $1^1/_2$ turns or so. If the No-Go gage doesn’t jam, this indicates that the thread is undersized. If the go-gage jams, this indicates that the threads are over-sized. The gages should be lightly lubricated with machine oil to minimize wear and prevent corrosion. Go No-Go gages comes in two types, adjustable and non-adjustable. The adjustable type has a gap as shown in figure 4. A screw sets the gap width and calibration lab personnel use the screw to calibrate the gage when compensating for wear. The non-adjustable type must be discarded when worn. For measurements made by these gages to be meaningful, the customer must have a process in place to regularly calibrate the gages or to determine if a gage is worn. If a worn gage is not discarded, a connector that is perfectly good may be rejected. For measuring internal threads, the go-no go gage shown in Figure 5 is used. The pass/fail indications for internal threads are the same as for external threads – the No-Go end of the gage should jam after $1^1/_2$ turns or so.

There are three grades of threads. Grade 1 is used for highly precision applications, such as aerospace, where the maximum thread contact area is critical for the strength of the joint. Grade 2 is used for industrial applications such as connector threads. Grade 3 is the loosest thread and is normally used for situations where the threads must successfully engage in the presence of dirt or grit, such as applications around oil wells or in engine compartments. If a grade 1 gage were used to test a grade 2 thread, an invalid failure would be indicated. If a grade 3 gage were used to test a grade 2 thread, an undersized thread could be passed.

Figure 4. *Go-No Go Gages for external threads*

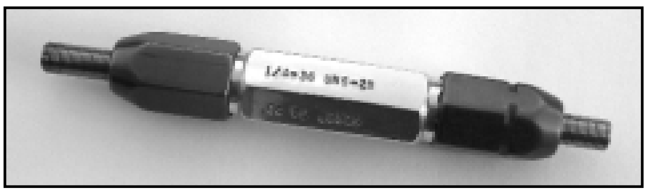


Figure 5. *Go-No Go Gages for internal threads*

Pitch Micrometer

The second measurement method uses a tool called a pitch micrometer. This tool is a specialized version of a standard micrometer. One side of the jaws has a pointed tip to fit down into the threads and the other side has an inverted V that fits over the top of a thread on the other side of the connector. The micrometer is carefully positioned on opposite sides of the thread to be measured and tightened to measure the pitch diameter of the thread. This positioning can be done using a microscope or other magnification to be sure the tips are properly placed. The pitch diameter is then read on the display. Using the pitch micrometer correctly requires more skill and knowledge than using the Go-No Go gages. The user has to be sure the jaws are properly positioned, reads the value, and then compares the measurement to the minimum and maximum specifications for the pitch diameter to determine if the thread is within specifications.

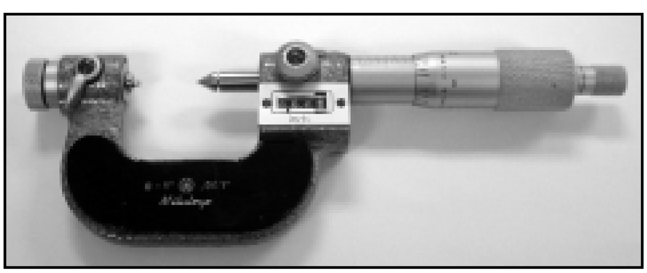


Figure 6. *Pitch Micrometer*

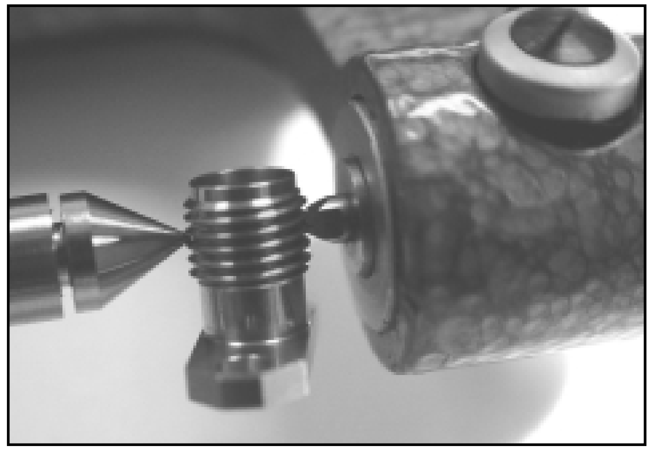


Figure 7. *Pitch Micrometer in use*

A pitch micrometer is calibrated to measure the pitch diameter of a thread. Figure 8 shows schematically how this works. The design of the probes is such that if all thread dimensions are correct, the pitch micrometer will read exactly the pitch diameter. On the other hand, if thread dimension is incorrect, the probes will not seat as they should and the pitch diameter will be wrong. For example, if the minor diameter is too small, the pointed probe will sit too deeply and the pitch diameter would measure too small. If the major diameter were incorrect (too large or too small), the V probe would cause the pitch diameter to be off correspondingly.

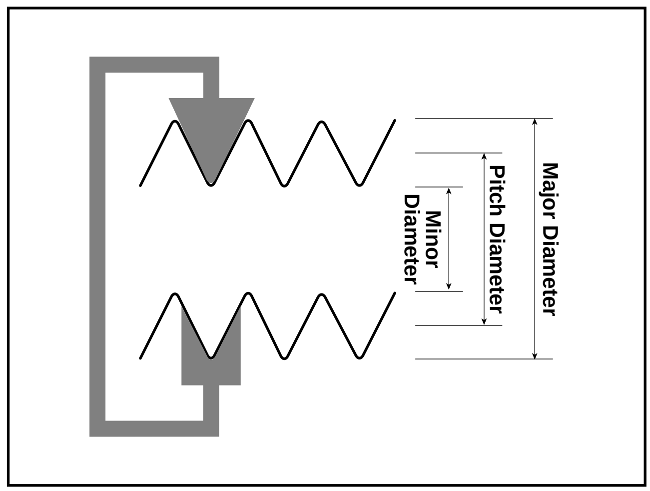


Figure 8. *How a Pitch Micrometer Works*

There can be offsetting errors in threads that the pitch micrometer by itself would not catch. For example, if the major diameter is too big and the minor diameter is too small, the errors would tend to cancel. Measuring the major diameter with a standard micrometer can discover this.

If a connector thread measures as marginally undersized, re-measurement by another gage or method would be wise to eliminate the possibility of gage wear or miscalibration.

In the real world, since K connectors are torqued to 8 inch-oz, having slightly undersized threads does not necessarily compromise microwave performance since, by tightening the coupling nut, a good ground may be achieved. However, if the threads are significantly undersized, it may not be possible to achieve the specified torque without applying force to the center pin.

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