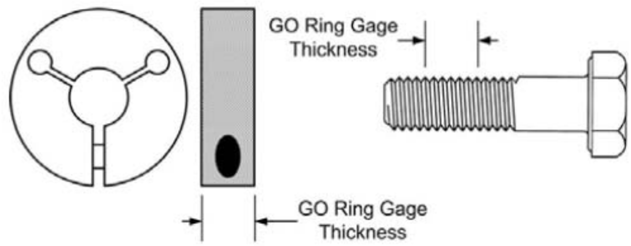
How To Determine A Thread's Pitch Variation



Sometimes when threads do not assemble smoothly it is appropriate to measure the thread's pitch to determine if it is within the allowable variation. The thread's pitch is the distance between the same location on two adjacent threads measured parallel to the thread's axis. Most of the time when dealing with threads the terms lead and pitch are used interchangeably. The pitch length is equal to one divided by the number of threads per inch.

If the distance between threads is greater than or less than the pitch length within the allowable variation the mating threads are likely to bind together before the head of the bolt or screw seats on the assembly's surface.

Table 3 of the American Society of Mechanical Engineers (ASME) B1.1 standard contains the allowable variation for the pitch length of threads. In the standard this is referred to as lead variation. Paragraph 9.1.6 states how this allowable variation is to be applied to determine the acceptability of a thread's lead variation.

ASME B1.1, Paragraph 9.1.6
For the requirements of paragraphs 9.1.4 and 9.1.5, lead variation values tabulated or calculated are the maximum variations from specified lead between any two points not farther apart than the length of the standard GO thread gage.

The easiest way to measure a thread's pitch is to measure the thread on an optical comparator using at least a 40 power magnification and a readout with a 0.0001" resolution. The procedure is as follows:

1. Position the thread on the comparator parallel to the table and perpendicular to the optical comparator's lens. Move the table in and out until all of the right hand flanks on all of the threads appear clear and sharp.

2. Place the intersection of the vertical and horizontal cross hairs on the comparator's screen on one of the right hand thread flanks near the right end of the screw or bolt's thread and zero the horizontal readout.

3. Move the table horizontally toward the left until the readout indicates the distance equal to the thickness of the appropriate GO ring gage. (Example: ½-13 2A GO Gage Thickness = 0.4375")

4. Next move the table horizontally to the right until the intersection of the horizontal and vertical cross hairs is located on the first right hand thread flank and record that exact distance.

5. Determine how many full threads are within that recorded distance and multiply the calculated pitch length by that number of threads (13 TPI = 0.076923; .4375 ÷ 0.076923 = 5.687). There are 5 complete threads within the 0.4375 GO thread ring thickness.

6. If the ½-13 thread's pitch is perfect the measured distance will be 0.3846 (5 X 0.076923).

7. Compare the actual measured value to the calculated gaging length value 0.3846.

8. The pitch length for a ½-13 Class 2A thread is acceptable if the actual measured value is within +/-0.00144 (allowable variation) of the calculated value.

The ring gage thicknesses, pitch variations for all 2A threads from #0 through 1 inch, and the related acceptable value ranges are tabulated in the tables below. The allowable variation for class 3A threads is .75 of that of the Class 2A thread.

If the measurement is below the minimum value the thread is said to have a short lead. If the measurement is above the maximum value the thread is said to have a long lead.

If an external thread can be rotated freely for its full length into the appropriate GO ring gage and its mating internal thread can freely accept a GO plug gage the lead variation is within acceptable limits for both threads and they should mate together freely. If thread binding during assembly is reported this procedure should be employed to verify the thread's pitch is within the allowable limits and is not the root cause of the thread binding.

Some designers erroneous believe that long thread engagement lengths make a joint stronger. That is not the case. When the length of engagement between threaded components exceeds 1 ½ times the nominal diameter (D) it is possible for both the internal and external threads to gage acceptably, but they bind together when the engagement exceeds 1 ½ D. Except in very special cases thread engagement length should never exceed 1 ½ D to avoid thread binding which prevents proper joint tightening.

UNC, Class 2A								
Size	TPI	Pitch	GO ring thickness	# Complete threads in ring	Gaging length	Allowable varriation	Maximum measurement	Minimum measurement
#1	64	0.0156	0.0938	6	0.0938	0.00058	0.0943	0.0932
#2	56	0.0179	0.0938	5	0.0893	0.00061	0.0899	0.0887
#3	48	0.0208	0.1563	7	0.1458	0.00066	0.1465	0.1452
#4	40	0.0250	0.1563	6	0.1500	0.00072	0.1507	0.1493
#5	40	0.0250	0.1563	6	0.1500	0.00075	0.1508	0.1493
#6	32	0.0313	0.1563	5	0.1563	0.00081	0.1571	0.1554
#8	32	0.0313	0.1875	6	0.1875	0.00084	0.1883	0.1867
#10	24	0.0417	0.1875	4	0.1667	0.00095	0.1676	0.1657
#12	24	0.0417	0.1875	4	0.1667	0.00098	0.1676	0.1657
1/4	20	0.0500	0.3438	6	0.3000	0.00107	0.3011	0.2989
5/16	18	0.0556	0.3438	6	0.3333	0.00115	0.3345	0.3322
3/8	16	0.0625	0.4375	7	0.4375	0.00127	0.4388	0.4362
7/16	14	0.0714	0.4375	6	0.4286	0.00136	0.4299	0.4272
1/2	13	0.0769	0.4375	5	0.3846	0.00144	0.3861	0.3832
9/16	12	0.0833	0.5625	6	0.5000	0.00150	0.5015	0.4985
5/8	11	0.0909	0.7500	8	0.7273	0.00159	0.7289	0.7257
3/4	10	0.1000	0.7500	7	0.7000	0.00170	0.7017	0.6983
7/8	9	0.1111	0.9375	8	0.8889	0.00182	0.8907	0.8871
1	8	0.1250	0.9375	7	0.8750	0.00196	0.8770	0.8730
Notes:			1			2		
1. Go ring thickness from ASME B47.1								
2. Allowances from ASME B1.1-2003, Table 3.								

UNF, Class 2A								
Size	TPI	Pitch	GO ring thickness	# Complete threads in ring	Gaging length	Allowable varriation	Maximum measurement	Minimum measurement
#1	72	0.0139	0.0938	6	0.0833	0.00055	0.0839	0.0828
#2	64	0.0156	0.0938	6	0.0938	0.00058	0.0943	0.0932
#3	56	0.0179	0.1563	8	0.1429	0.00064	0.1435	0.1422
#4	48	0.0208	0.1563	7	0.1458	0.00069	0.1465	0.1451
#5	44	0.0227	0.1563	6	0.1364	0.00072	0.1371	0.1356
#6	40	0.0250	0.1563	6	0.1500	0.00075	0.1508	0.1493
#8	36	0.0278	0.1875	6	0.1667	0.00081	0.1675	0.1659
#10	32	0.0313	0.1875	6	0.1875	0.00087	0.1884	0.1866
#12	28	0.0357	0.1875	5	0.1786	0.00092	0.1795	0.1777
1/4	28	0.0357	0.3438	9	0.3214	0.00095	0.3224	0.3205
5/16	24	0.0417	0.3438	8	0.3333	0.00107	0.3344	0.3323
3/8	24	0.0417	0.4375	10	0.4167	0.00110	0.4178	0.4156
7/16	20	0.0500	0.4375	8	0.4000	0.00121	0.4012	0.3988
1/2	20	0.0500	0.4375	8	0.4000	0.00124	0.4012	0.3988
9/16	18	0.0556	0.5625	10	0.5556	0.00130	0.5569	0.5543
5/8	18	0.0556	0.7500	13	0.7222	0.00156	0.7238	0.7207
3/4	16	0.0625	0.7500	12	0.7500	0.00144	0.7514	0.7486
7/8	14	0.0714	0.9375	13	0.9286	0.00156	0.9301	0.9270
1	12	0.0833	0.9375	11	0.9167	0.00170	0.9184	0.9150
Notes:			1			2		
1. Go ring thickness from ASME B47.1								
2. Allowances from ASME B1.1-2003, Table 3.								

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