(Errata 1995)
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American Gear Manufacturers Association

Technical Resources

American National Standard

Tooth Thickness Specification and Measurement

ANSI/AGMA 2002-B88

Tooth Thickness Specification and Measurement
ANSI/AGMA 2002–B88
(Revision of AGMA 231.52–1975)

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ABSTRACT

This Standard establishes the procedures for determining tooth thickness measurements of external and internal cylindrical involute gearing. It includes equations and calculation procedures for the commonly used measuring methods. A specific tooth thickness measurement limit can be established from the design thickness or from another tooth thickness measurement. The procedures can be entered with an established design tooth thickness, or with actual tooth thickness measurements. The effect of tooth geometric quality variations on tooth thickness measurements is discussed. Backlash information is provided in an appendix.

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FOREWORD

[This foreword, footnotes, and appendices, if any, are provided for informational purposes only and should not be construed as part of ANSI/AGMA 2002–B88, *Tooth Thickness Specification and Measurement.*]

This Standard presents calculation procedures for determining tooth thickness measurements of external and internal cylindrical involute gearing. It supersedes AGMA 231.52, *Inspection – Pin Measurement Tables for Involute Spur Gears.*

This Standard has been prepared to consolidate previously published AGMA tooth thickness information, to add more information on internal and helical gears and to add details on more measurement methods.

Previous AGMA publications have presented this information in tabular form, calculated for 1 DP and standard tooth proportions, with adjustment factors for nonstandard conditions. This Standard is arranged for direct calculation of the desired results, to eliminate the intermediate calculation steps and interpolation previously required.

The study of tooth thickness and backlash problems has been a major interest of gear technicians throughout the history of the industry. In the last fifty years, many clarifications and contributions have been made by men such as Buckingham, Candee, Leming, Vogel, and Wildhaber. Their work is consolidated here, without further attribution, and the work of more recent contributors is added where it improves the presentation.

The appendices provide further information on reasonable allowances for backlash and tooth thickness deviation, sample calculations, and information on four uncommon methods of measurement specified on some gear drawings.

The treatment of the effects of tooth profile, pitch, lead, and runout deviations on tooth thickness measurement is new in this Standard.

The information on backlash control is new in an AGMA Standard. It is based on AGMA Paper P239.14, *Assured Backlash Control – The ABC System.*[1]

The first draft of this revision was made in February 1984.

This version was approved by the AGMA membership on October 9, 1988 and as an American National Standard on October 17, 1988.

Suggestions for the improvement of this Standard will be welcome. They should be sent to the American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, Virginia, 22314.

ERRATA July, 1992
The following editorial corrections have been made to ANSI/AGMA 2002–B88, *Tooth Thickness Specification and Measurement*, (originally printed October 1988). These changes, discovered after publication, have been made in the second standard printing, as shown below:

PAGE	ITEM	CHANGE
10	Fig 3–1	The position of minimum and maximum backlash is shown on the specified circle, also 1/2 specified tolerance and 1/2 specification bands labeled correctly.
26	Fig 3–1	The angle Ψ_b and the assumed form diameter, $D_o - 4a$, indicated correctly.
29	Eq 8.2	The right hand bracket should be at the end, with the full equation reading, $f_3 = \text{arc inv}\left[\frac{P_{nd}(t_1 + t_2) - p}{N_1 + N_2} + \text{inv} f_c\right]$ (Eq 8.2)
32	Table A–1	The last value in the table, for 64 inch center, should read 0.058.

ERRATA June, 1995 (Additional correction made in this printing).

PAGE	ITEM	CHANGE
29	Eq 8.2	Changed to transverse plane. $\phi_3 = \text{arc inv}\left[\frac{P_d(t_1 + t_2) - \pi}{N_1 + N_2} + \text{inv}\phi_s\right]$ (Eq. 8.2)

[1] Numbers in brackets refer to the bibliography.

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Table of Contents

Table of Contents (cont)

1. Scope

This Standard establishes the calculation procedures for determining tooth thickness measurements of external and internal cylindrical involute gearing.

The information is intended for use by the gear specifier or manufacturer in establishing values for tooth thickness measurement limits.

CAUTION: It is important that tooth thickness measurement limits be reasonable for the specified quality class of the gears, to permit economical manufacture. This Standard provides guidance in the selection of reasonable tooth thickness measurement limits.

The designed tooth thickness is established from engineering considerations. It is determined by gear geometry, gear tooth strength, and backlash. The methods for establishing designed tooth thickness for a given application are beyond the scope of this Standard.

This Standard assumes the designed tooth thickness is known in cases where the values for various measuring techniques are to be established.

It includes equations and procedures for the following measuring methods:

(1) Chordal
(2) Pins (wires, rolls and balls)
(3) Span
(4) Composite Action Test

This Standard also establishes methods of determining tooth thickness of a gear based upon measurement limits by means of pins, span, chordal thickness or composite action test. These methods are often used to convert a tooth thickness specified by one method, such as *over pins* to another more convenient method, such as *span over X teeth*.

CAUTION: The effect of tooth geometry variations on tooth thickness measurements made by different measuring methods may be significant. This must be considered if close control of backlash is required. When this is necessary the tooth thickness should be measured by the method specified on the drawing. Refer to 3.8 for additional discussion of the problem.

Examples included are for coarse pitch gears. The same mathematical principles apply to gear teeth of all sizes. For information on fine pitch gears, see AGMA 370.01, *Design Manual for Fine Pitch Gears*.

This Standard does not contain tolerances on tooth thickness. See AGMA 2000–A88, *Gear Classification and Inspection Handbook – Tolerances and Measuring Methods for Unassembled Spur and Helical Gears (Including Metric Equivalents)*, for tolerances.

AGMA 115.01, *Reference Information – Basic Gear Geometry* is a source for the derivations and detailed explanations of the geometrical relationships used here.

AGMA 112.05, *Gear Nomenclature (Geometry) Terms, Definitions, Symbols and Abbreviations* is a source of definitions of common gear terms as used in this Standard.

2. Symbols, Terminology and Definitions

2.1 Symbols and Terminology. Symbols and terminology used in this Standard are shown in Table 2–1 and Table 2–2.

NOTE: The symbols, terminology, and definitions used in this Standard may differ from other AGMA standards. The user should not assume that familiar symbols can be used without a careful study of these definitions.

SI (Metric) units of measure are shown in parentheses in Table 2–1, Table 2–2 and in the text. Where equations require a different format or constant for use with SI units, a second expression is shown after the first, indented, in smaller type, and with "M" included in the equation number.

Example:

$$p_x = \frac{\pi}{P_{nd} \sin \psi_s} \qquad \text{(Eq 4.4)}$$

$$p_x = \frac{\pi m_n}{\sin \psi_s} \qquad \text{(Eq 4.4M)}$$

2.2 Definitions. The terms used, wherever applicable, conform to the following standards:

ANSI Y10.3 – 1968, *Letter Symbols for Quantities Used in Mechanics of Solids*

AGMA 112.05, *Gear Nomenclature, Terms, Definitions, Symbols, and Abbreviations*

AGMA 600.01, *Standard for Metric Usage*