



American
Gear Manufacturers
Association

Technical Resources

ANSI/AGMA 2011-B14
(Revision of ANSI/AGMA 2011-A98)

American National Standard

Cylindrical Wormgearing Tolerance and Inspection Methods

**American
National
Standard**

Cylindrical Wormgearing Tolerance and Inspection Methods

ANSI/AGMA 2011-B14

[Revision of ANSI/AGMA 2011-A98]

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing or using products, processes or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretation of this standard should be addressed to the American Gear Manufacturers Association.

CAUTION NOTICE: AGMA technical publications are subject to constant improvement, revision or withdrawal as dictated by experience. Any person who refers to any AGMA Technical Publication should be sure that the publication is the latest available from the Association on the subject matter.

[Tables or other self-supporting sections may be referenced. Citations should read: See ANSI/AGMA 2011-B14, *Cylindrical Wormgearing Tolerance and Inspection Methods*, published by the American Gear Manufacturers Association, 1001 N. Fairfax Street, Suite 500, Alexandria, Virginia 22314, <http://www.agma.org>.]

Approved October 3, 2014

ABSTRACT

This standard describes and defines variations that may occur in unassembled wormgearing. It displays measuring methods and practices, giving suitable warnings if a preferred probe cannot be used. The applicability of single or double flank composite testing is discussed, using a reference gear. Tooth thickness measurement is shown using direct measurement as well as the use of measurements over wires or pins. Equations for the maximum variations are given for the stated ranges, as a function of size, pitch and tolerance grade.

Published by

**American Gear Manufacturers Association
1001 N. Fairfax Street, Suite 500, Alexandria, Virginia 22314**

Copyright © 2014 by American Gear Manufacturers Association
All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without prior written permission of the publisher.

Printed in the United States of America

ISBN: 978-1-61481-090-2

Contents

Foreword	v
1 Scope	1
1.1 Tolerance equations and tables	1
1.2 Measuring methods and practices	1
1.3 Exceptions	1
2 Symbols, terms and definitions	1
2.1 Symbols	1
2.2 Definition of terms	1
3 Manufacturing and purchasing considerations	5
3.1 Manufacturing certification	5
3.2 Process control	6
3.3 Inspection methods	6
3.4 Additional considerations	6
3.4.1 Backlash allowance	6
3.4.2 Material furnished by the purchaser	7
3.4.3 Matching gears as sets	7
3.4.4 Reference gears for composite measurement	7
3.4.5 Contact pattern	7
3.4.6 Replacement gearing	7
3.5 Acceptance criteria	7
3.6 Evaluation of tolerance grade	7
4 Measuring methods and practices	7
4.1 Worm thread radial runout, V_{rW}	7
4.1.1 Causes of worm thread radial runout, V_{rW}	8
4.1.2 Alternative method of determining worm thread runout, V_{rW}	8
4.2 Worm pitch variation, V_{pW}	8
4.2.1 Worm pitch variation, V_{pW} - method A (recommended for 2 to 4 threaded worms only)	8
4.2.2 Worm pitch variation, V_{pW} - method B (recommended for 2 to 20 threaded worms)	9
4.2.3 Causes of worm pitch variations, V_{pW}	10
4.2.4 Worm accumulative pitch variation, V_{apW}	10
4.3 Worm profile variation, $V_{\phi W}$	10
4.4 Worm lead variation, V_{lW}	12
4.5 Worm lead form variation, V_{lFW}	12
4.6 Wormgear tooth runout, V_{rG}	12
4.6.1 Form of axial runout	12
4.6.2 Form of radial runout	12
4.6.3 Runout measuring methods	13
4.6.4 Cause of wormgear tooth runout, V_{rG}	13
4.6.5 Alternative methods of determining wormgear tooth runout, V_{rG}	13
4.7 Wormgear pitch variation, V_{pG} , and accumulated pitch variation (total index variation), V_{apG}	13
4.7.1 Spacing	13
4.7.2 Reference axis	14
4.7.3 Reference axial surfaces	14
4.7.4 Reference identification of tooth data	14
4.7.5 Location of probe or probes	14
4.7.6 Number of measurements	14
4.7.7 Basic devices for wormgear pitch and accumulated pitch variation measurement	15
4.7.8 Use and interpretation of the two probe device	15
4.7.9 Use and interpretation of the single probe device	16
4.7.10 Total accumulated pitch variation within a sector of k pitches, V_{apkG} (total index variation within a sector of k pitches)	17
4.7.11 Causes of wormgear pitch variation, V_{pG}	17

4.8	Wormgear profile variation, $V_{\phi G}$	18
4.9	Master worms.....	18
4.10	Double flank composite.....	18
4.10.1	Applicability of double flank composite inspections.....	18
4.10.2	Double flank testing procedures.....	19
4.11	Single flank composite.....	19
4.11.1	Applicability of single flank composite inspections.....	19
4.11.2	Single flank testing procedures.....	19
4.12	Worm thread thickness measurement.....	20
4.12.1	Gear tooth caliper.....	20
4.12.2	Measuring over pins.....	21
5	Equations for worm and wormgear tolerances.....	22
5.1	Worm runout tolerance.....	22
5.2	Worm profile variation tolerance.....	22
5.3	Worm pitch variation tolerance.....	22
5.4	Worm total accumulated pitch variation tolerance.....	23
5.5	Worm lead variation tolerance.....	23
5.6	Worm lead form tolerance.....	23
5.7	Gear runout tolerance.....	23
5.8	Gear pitch variation tolerance.....	23
5.9	Gear total accumulated pitch tolerance.....	23

Annexes

Annex A (informative)	Inspection tolerance tables.....	24
Annex B	Bibliography.....	45

Tables

Table 1	- Symbols used.....	2
---------	---------------------	---

Figures

Figure 1	- Functional part of the profile - cutoff points, drop-off region.....	4
Figure 2	- Lead and lead form variation.....	4
Figure 3	- Worm thread runout inspection, V_{rW}	8
Figure 4	- Worm pitch variation inspection, V_{pW} - method A.....	9
Figure 5	- Worm pitch variation inspection, V_{pW} - method B.....	10
Figure 6	- Worm thread profile inspection, $V_{\phi W}$	11
Figure 7	- Worm thread profile tolerance band, $V_{\phi TW}$	11
Figure 8	- Worm thread lead inspection, V_{lW}	12
Figure 9	- Wormgear tooth runout, V_{rG}	13
Figure 10	- Location of probe - wormgear pitch variation, V_{pG}	14
Figure 11	- Two probe device.....	15
Figure 12	- Schematic of single probe device.....	15
Figure 13	- Relationships of pitch variation, V_{pG} , and accumulated pitch variation, V_{apG}	16
Figure 14	- Pitch variation, V_{pG} , graphical data from two probe device.....	17
Figure 15	- Pitch variation V_{pG} , and accumulated pitch variation, V_{apG} : graphical data from single probe device.....	17
Figure 16	- Schematic of a double flank wormgear tester.....	18
Figure 17	- Schematic of a single flank wormgear tester.....	19
Figure 18	- Thread thickness measurement by means of a gear tooth caliper.....	20
Figure 19	- Thread thickness measurement over pins.....	20

Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of ANSI/AGMA 2011-B14, *Cylindrical Wormgearing Tolerance and Inspection Methods*.]

The purpose of this standard is to establish geometrical accuracy communication between a manufacturer and purchaser of unassembled cylindrical wormgearing with axes at right angles.

AGMA 390.02 September 1964 was a replacement for AGMA 234.01 for fine pitch wormgearing. ANSI/AGMA 2000-A88 is a partial revision of AGMA 390.03, but does not cover wormgearing. AGMA 390.03a of 1988 still only covered fine pitch wormgearing. ANSI/AGMA 2011-A98 then is a replacement for AGMA 390.03a for fine pitch wormgearing. In addition, it also covers coarse pitch wormgearing.

The Cylindrical Wormgearing Committee began working on ANSI/AGMA 2011-A98 in August, 1993. At that time, it was determined the International Standards Organization's (ISO) method for tolerance grades would be used in this standard.

ANSI/AGMA 2011-A98 was approved by the AGMA membership in June, 1998 and approved as an American National standard on October 1, 1998.

The new ANSI/AGMA 2011-B14 was required to correct a typographical error found in equation 18 of ANSI/AGMA 2011-A98. The metric edition of the standard was not affected.

The first draft of ANSI/AGMA 2011-B14 was created in May 2013. It was approved by the membership in June 2014 and as an American National Standard on October 3, 2014.

Suggestions for improvement of this standard will be welcome. They may be submitted to tech@agma.org.

PERSONNEL of the Wormgearing Committee

Chairman: Martin Peculis Cleveland Gear Company
Vice Chairman: David Payne Baldor Electric Company (Clarksville)

ACTIVE MEMBERS

E. Ayers Boston Gear
R.G. Estell The Estell Group
R. Holdsworth Peerless-Winsmith, Inc.
T.G. Scott David Brown Gear Systems Limited
P. Wagaj Gleason Metrology Systems Corporation

American National Standard -

Cylindrical Wormgearing Tolerance and Inspection Methods

1 Scope

This standard establishes a classification system which may be used to communicate geometrical accuracy specifications of unassembled cylindrical wormgearing with axes at right angles. It also provides information on measuring methods and practices. This standard provides the gear manufacturer and the gear purchaser with a mutually advantageous reference for uniform tolerances and inspection procedures. Tolerance grades 3 through 12 are defined in this standard and are based on the relative effect of geometrical errors on conjugate action for wormgear sets acting as speed reducers.

1.1 Tolerance equations and tables

Tolerance equations are provided in clause 5 for calculating the maximum values allowed by the specific tolerance grade. Tables are provided in annex A for reference.

1.2 Measuring methods and practices

Measuring methods and practices are included in order to promote uniform inspection procedures (see clause 4). These methods permit the manufacturer and purchaser to conduct measuring procedures which are accurate and repeatable to a degree compatible with the specified tolerance grade.

1.3 Exceptions

This standard applies to individual worm and gear components. It does not establish a tolerance grade for enclosed drive assemblies. Establishing ratings based on tolerance grade is beyond the scope of this standard. Gear design and backlash are also beyond the scope of this standard. Refer to the latest AGMA Publications Catalog for applicable standards. This standard does not apply to worms with mean diameters larger than 16 inches, nor does it apply to wormgears with mean diameters larger than 100 inches. This standard does not apply to geometry finer than 0.063 axial pitch. This standard does not apply to spiral gears or any type other than cylindrical single enveloping wormgearing.

2 Symbols, terms and definitions

The symbols, terms and definitions used in this standard are, wherever possible, consistent with ANSI/AGMA 1012-G05 and other approved AGMA documents.

2.1 Symbols

Table 1 is a list of the symbols used in this standard, along with the associated terms. The "Where first used" column gives the clause or equation number where the particular symbol is first used.

2.2 Definition of terms

axial plane: The axial plane is the plane containing the line of axis of the worm. Diameters may be measured in this plane but thread surfaces would require a theoretical knife edge measurement. These measurements may be obtained by indirect means using normal plane measurements. The probe measurement in Method "A" will give a direct axial measurement, however, since the normal to probe center is repeated at each point.