American Gear Manufacturers Association

AGMA 916-A19

AGMA Information Sheet

Face Gears with Intersecting Perpendicular Axes

AGMA 944-A19

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ABSTRACT

This information sheet describes design calculations for spur pinions and face gears that intersect with perpendicular axes. The procedure described in this document will result in a face gear tooth geometry that is defined by the generating action of a reciprocating spur gear cutter which incorporates certain essential features of the mating pinion. The method described applies to all modules and profile angles.

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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 AGMA 916-A19, *Face Gears with Intersecting Perpendicular Axes*.]

This information sheet is dedicated to Irving Laskin. His participation and inspiration led to the development of this information sheet. His thoroughness, contributions of his time, and enthusiasm for gearing, along with the contributions of his fellow committee members were instrumental in the creation of this document.

Prior to the first publication of AGMA 916-A19, AGMA's technical library included a withdrawn document AGMA 203.03 (1973), *Fine Pitch on-Center Face Gears for 20 Degree Involute Spur Pinions*. AGMA 916-A19 is a complete rewrite of the former document and now encompasses all modules and profile angles. At the same time, it eliminates all of the graphical calculation methods previously used and replaces them with computational methods. A more detailed explanation of the design and manufacturing is provided.

The first draft of AGMA 916-A19 was made in March 1996. It was approved by the AGMA membership in June 2019.

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

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American Gear Manufacturers Association –

Face Gears with Intersecting Perpendicular Axes

1 Scope

This document describes design calculations for spur pinions and face gears that intersect with perpendicular axes. Face gears can also be designed in non-right-angled arrangements, helical arrangements or offset axis configurations. These methods go beyond the scope of this document.

The procedure described in this document will result in a face gear tooth geometry that is defined by the generating action of a reciprocating spur gear cutter which incorporates certain essential features of the mating pinion.

The manufacturing approach described by this procedure is outlined in Clause 4.

1.1 Simultaneous definition of face gear, pinion and cutter

The design approach described in this document simultaneously defines the spur pinion, the spur gear cutter, and the resulting face gear. In some designs, it may be advantageous to first define a cutter, and then a spur gear pinion and a face gear, while in other designs it may be beneficial to define a spur gear pinion and then a cutter and face gear. In this document, either approach can be employed as the calculations proceed simultaneously.

A design example is provided in Annex C.

1.2 Limits on pinion and face gear proportions

The design analysis procedures described in this document are general enough to be applied to any set of pinion and face gear proportions provided that the proportions of the pinion are defined by a straight sided basic rack either with a sharp or circular arc fillet.

In applying this procedure, the generating action of the face gear cutter may result in a sweep condition that may remove functional material from the generated face gear tooth surface. As a result, this procedure is only recommended for designs with,

- pinions with 8 or more teeth;
- a gear ratio of at least 1.5:1;
- a system module of at least 0.2 mm.

Users of this information sheet must be aware that even within these limits, the resulting design needs to be verified for functionality.

The information in this manual is meant to serve only as a guide to the designer of face gear drives. It is not intended that it be the procedure which must be followed in the design of such gears, nor is it implied that using the procedures and data will necessarily result in gears that will meet the requirement in every application. It remains the responsibility of the designer to properly evaluate conditions in a specific application and to make use of prior experience or proper testing to confirm the suitability of the design.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this information sheet. At the time of publication, the editions indicated were valid. All publications are subject to revision. Users of this information sheet are encouraged to investigate the possibility of

applying the most recent editions of the publications listed. Each document is crossed referenced in the body of this information sheet to indicate how it applies.

ANSI/AGMA 1012-G05, *Gear Nomenclature, Definition of Terms with Symbols*

ANSI/AGMA 1103-H07, *Tooth Proportions for Fine- Pitch Spur and Helical Gearing (Metric Edition)*

ISO 53:1998, *Cylindrical Gears for General and Heavy Engineering – Standard Basic Rack Tooth Profile*

ANSI/AGMA 2015-2-B15, *Gear Tooth Flank Tolerance Classification System – Definitions and Allowable Values of Double Flank Radial Composite Deviations*

AGMA 915-2-B20, *Inspection Practices – Part 2: Double Flank Radial Composite Measurements*

3 Definitions and symbols

3.1 Face gear terminology

Definitions of terms specific to face gears are given below.

3.1.1 Cutting distance

The distance between the pinion center line and the face gear mounting surface. See Figure 1.

3.1.2 Face gear face width

The radial distance from the inside diameter of the face gear to the outside diameter of the face gear. See Figure 2.

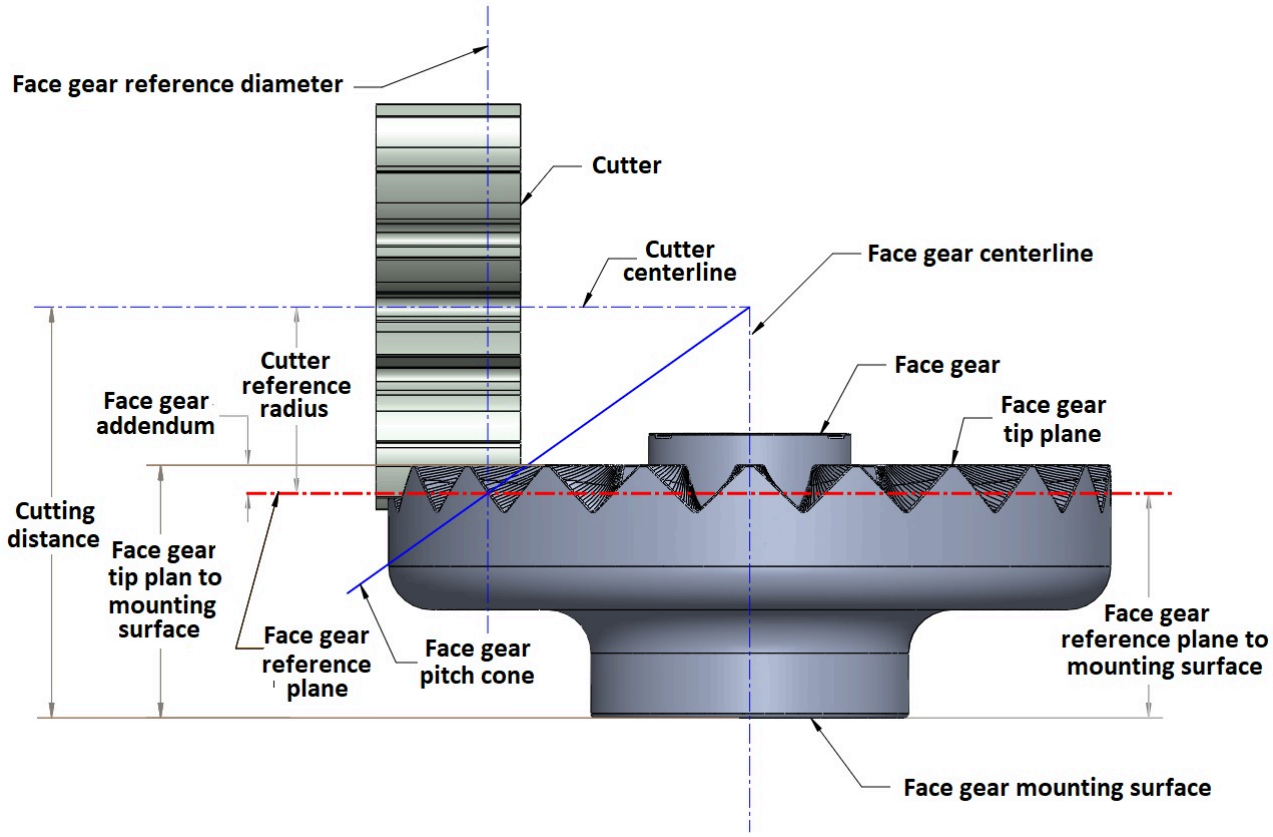

Figure 1 – Face gear and cutter definitions

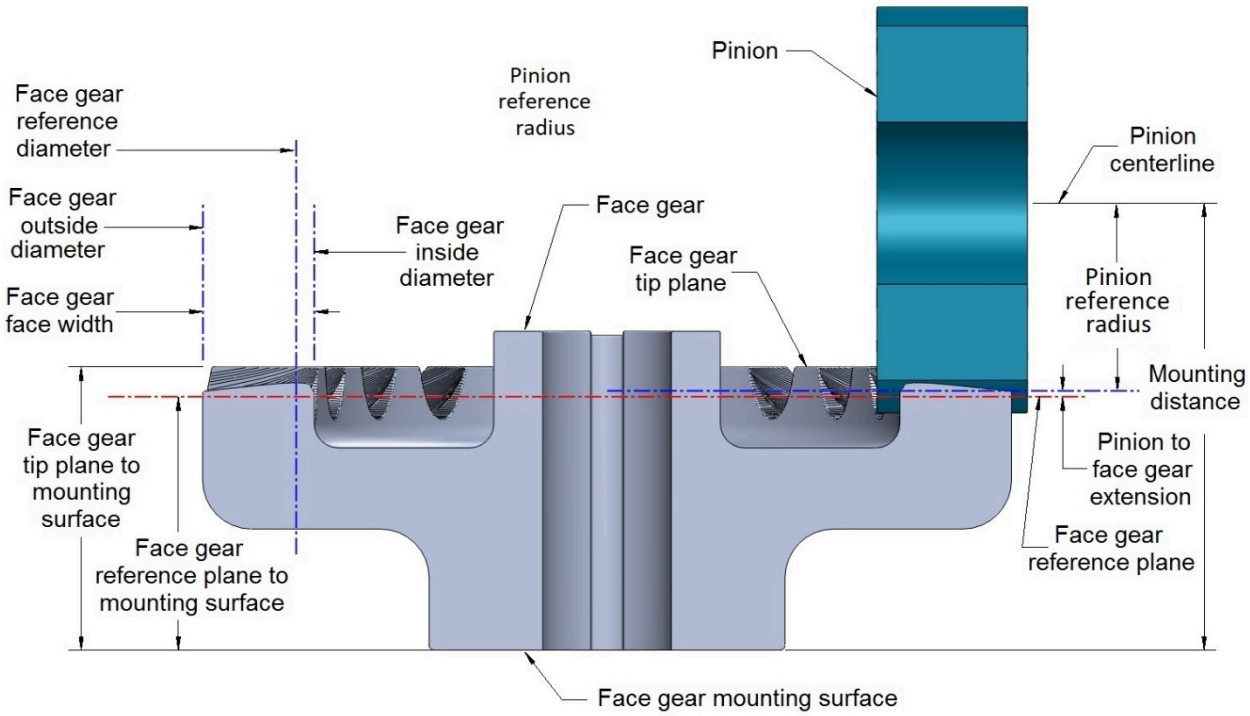

Figure 2 – Face gear and pinion definitions

3.1.3 Face gear inside diameter

The diameter at which the face gear teeth end radially towards the centerline. See Figure 2.

3.1.4 Face gear pitch cone

A theoretical conical surface that extends from the intersection point between the cutter and face gear center lines through the reference diameter of the face gear at the face gear's reference plane. See Figure 1 where the figure simplifies the visualization of the cone using a single line.

NOTE 1: The pitch cone is based on the cutter's relationship with the face gear and not the pinion.

NOTE 2: The pitch cone is used to calculate the location of the reference plane at each rack section. See clause 7.1.2.

3.1.5 Face gear outside diameter

The diameter at which the face gear teeth end radially away from the centerline. See Figure 2.

3.1.6 Face gear reference diameter

The diameter at which the face gear tooth thickness and pressure angle are defined at the intersection to the face gear reference plane. See Figure 1.

3.1.7 Face gear reference plane

The plane parallel to the face gear tip plane at which the face gear tooth thickness is defined. The location of this plane is defined by its tangency with the reference diameter of the cutter during the manufacturing process. See Figure 1.

3.1.8 Face gear reference plane to mounting surface

The distance from the face gear reference plane to the mounting or locating face of the face gear. See Figure 2.