# ENGINEERING NOTE

**REDUCERS**

## Backlash in Gearing

What is backlash and how is it measured or indicated?

Backlash for any reducer is defined as the total air gap between the gear set or gear sets, measured at the output gears at the gear pitch diameter, with the input shaft held stationary.

The backlash in usually indicated under no load and is not to be confused with a torque wind-up or twist that results when a significant torque load is applied to the output shaft with the input shaft held stationary.

For many applications, the amount of backlash has little importance. Gears which are driving in only one (1) direction, with no reversals of torque will have their driving faces continually in contact. As long as there is sufficient backlash for thermal growth of the gears, backlash is not a concern to the user.

It is, however, recognized that there are some gearing applications where a tight mesh (reduced backlash) may be required.

In establishing backlash tolerances at the design stage, the following points must be considered:

- Center distance tolerance
- Parallelism of the gear axle
- Side run out or wobble of the gears
- Tooth thickness tolerance
- Pitch line run out tolerance
- Profile tolerance
- Deflection under load
- Gear tooth wear
- Thermal expansion of gears and housing

A tight mesh may result in:

- Objectionable sound
- Increased power loss
- Overheating
- Rupture of the lubricant film
- Overloaded bearings
- Premature gear failure

Specifying unnecessarily close backlash tolerances will increase the cost of gearing.

Eurodrive machining tolerances and gear grinding procedures allow us to assemble the reducers with a minimum amount of backlash without causing any damage to the gearing.

Eurodrive offers a commercial grade of gearing. This means the gears are made in production lots are held to accurate, but standard, company tolerances. We are not offering special gearing or housings to eliminate the backlash because no matter how one reduces the backlash, there must be space for thermal growth of the gears.

From past experience with vendors, we have learned that our standard gearing seems to have less backlash than competitive units of the same size. This means to meet our backlash tolerances others may have to offer special gearing.

Besides backlash, there is additional deflection possible in the gearing when under full load which may appear as backlash.

When an input shaft is held stationary and the output shaft is twisted under a certain load, there will be backlash take-up, plus deflection (bending) of the gear teeth and key clearance take-up. The total twist can be considerably more than the backlash.

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When requesting backlash data from Eurodrive, the following can be supplied:

1. Backlash between the gears at no load when the input shaft is held stationary
   The backlash is indicated at the output shaft in degrees of rotation.
2. Total deflection of the gears and keys, under full load, when the input shaft is held stationary.
   Backlash indicated at the output shaft in degrees of rotation.

When a gear reducer has to be supplied with a minimum of backlash you must specify on the order - "minimum backlash".

The keys and keyways will be treated with Loctite #601 to insure a zero clearance between keys and keyways.

As a rule, the following can be used:

**Helical-Worm Reducers**

1. No load backlash: Approximately 0.2°
2. Backlash plus teeth deflection in the CW and then CCW direction under full load is approximately 1.2°

**Parallel and Helical-Bevel**

1. No load backlash: Approximately 0.25°
2. Backlash plus teeth deflection in the CW and then CCW direction under full load is approximately 0.75°

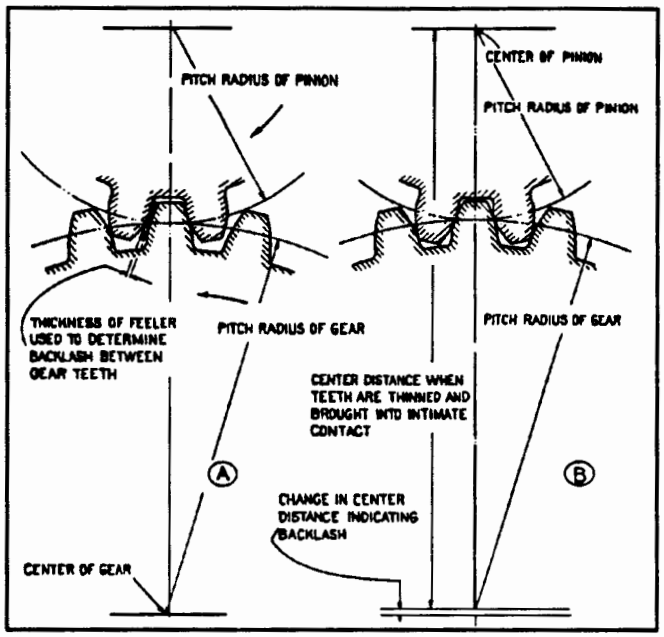


Diagram Illustrating Two Methods of Determining Backlash Between Gear Teeth

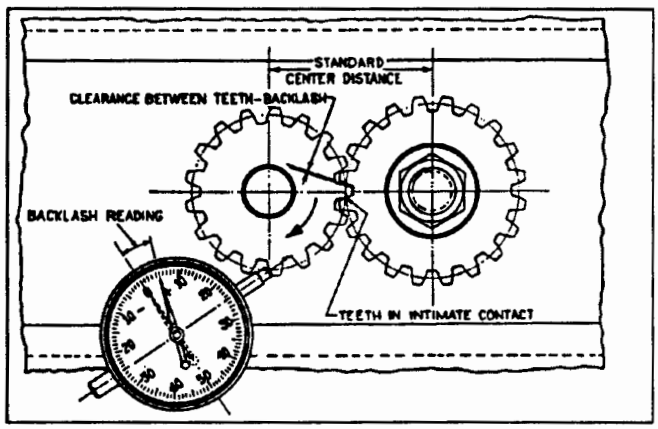


Diagram Illustrating Method of Measuring Backlash with Dial Indicator – Gears Held on Pins at Standard Center Distance