Input Shaft Tradeoff Options for Single Speed Gear Reducers

EV work continues despite reduction in volume

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Greetings 2026! As expected, EV demand has waned following some deregulation and tax credits being dropped as of September 2025. For us industry folks, this is simply reality catching up with the narrative. On the plus side, 2025 was a very good year for global vehicle sales–the best since 2019 (Ref. 1). A good economy can forgive many blunders. As gearbox designers, our work continues as our EV offerings are likely a permanent part of our product lineup, even if at a reduced volume. When it comes to single speed offset gearboxes, many OE's have a similar 3 parallel shaft design, running ratios typically between 7:1 to 15:1. Some higher speed boxes are going above 20:1 ratio now, but the basic architecture is unchanged. The Tesla design shown here is a common baseline design:

***Figure 1—Photo courtesy of Munro Live on Instagram: "Partial Dissemble of the 2018 Tesla Model 3 Helical Gearbox." Instagram, 2017,* www.instagram.com/p/COiQJ1rniM1**

There is a lot of discussion around the nuances of bearing type and placement. Here, we will look at the rotor and input shaft and discuss and compare the common alternatives.

To summarize the option we will be reviewing, we have:

1. Four-bearing integrated input pinion gear (machined on shaft).
2. Four-bearing splined input pinion gear.
3. Three-bearing, fixed motor shaft.
4. Three-bearing, fixed input gear.
5. Three-bearing, single shaft.
6. Two-bearing, single shaft.

For this study, we will use a nominal driving load of 100 Nm for a realistic evaluation case. All results are based on nominal fits and clearances. We will only focus on the input gear (Gear A) for misalignment since we are not evaluating any intermediate shaft effects.

1. **Four-bearing, integrated input pinion gear**
   Pro–Minimum misalignment. Able to optimize motor bearings. Easy to electrically insulate.
   Con–High scrap cost on integrated pinion.
2. **Four-bearing splined input pinion gear**
   Pro–Reduced scrap cost.
   Con–Added part assembly. Higher pinion misalignment.
3. **Three-bearing, fixed motor shaft**
   Pro–Eliminate 1 bearing. Reduced axial space.
   Con–Much higher pinion misalignment.
4. **Three-bearing, fixed pinion shaft**
   Pro–Eliminate 1 bearing. Reduced axial space. Good pinion support.
   Con–higher rotor misalignment.
5. **Three-bearing, single shaft**
   Pro–Eliminate any potential lash in spline connection.
   Con–Indeterminate loading on bearings. Cannot optimize bearings with loading uncertainty. Gear deflection can change based on loading and tolerances.

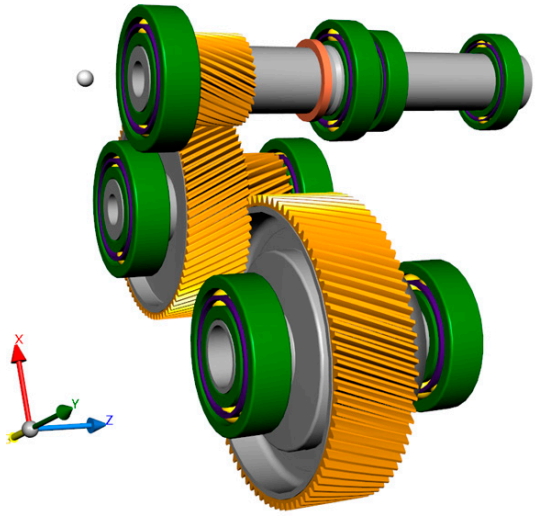

Figure 2—A simple design is modeled in **Masta** *for comparison study.*

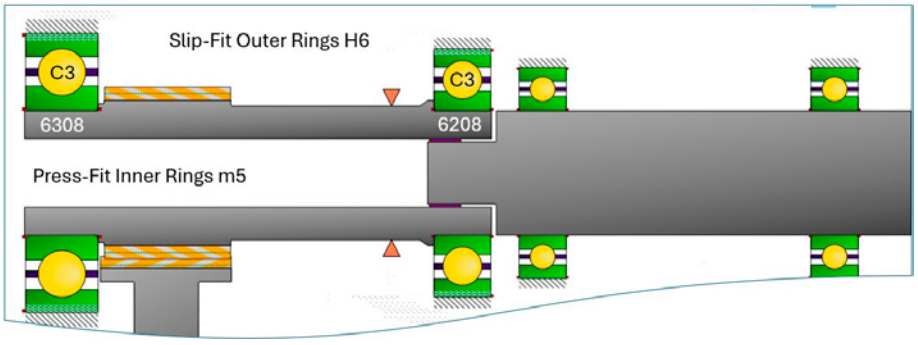

Figure 3—Four-bearing, machined pinion design.

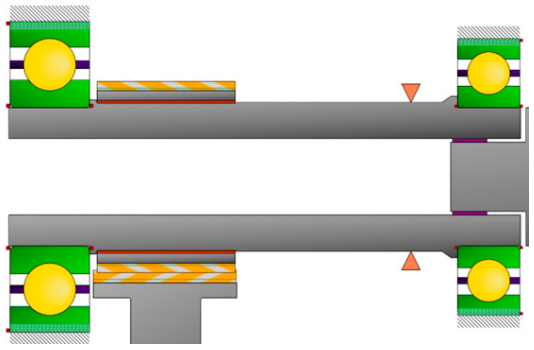

Figure 4—Four-bearing, splined input pinion.

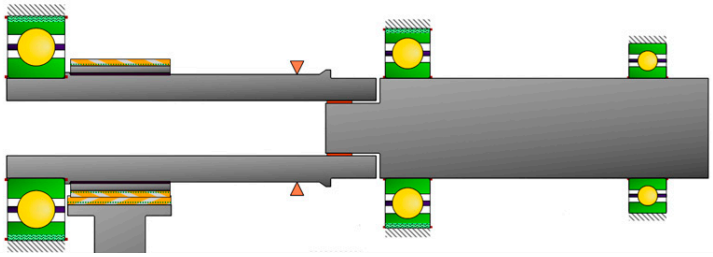

Figure 5—Three-bearing, fixed motor shaft.

6. Two-bearing, single shaft
Pro–Eliminate spline lash.
Predictable gear deflection.
Reduced parts and assembly.
Con–Cost.

Conclusion

In addition to this simple comparison, cylindrical bearings can also be reviewed in different locations. For these ball bearing designs, we are assuming all bearings have equivalent quality and performance standards. When all options are considered along with housing type and capability, the tradeoff study becomes substantially more involved. For a quick, high-level pass, take a look at the table below to see how these options rank.

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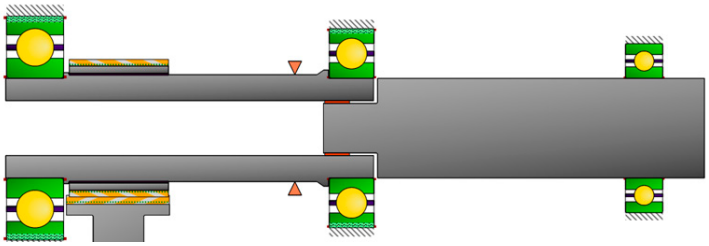

Figure 6—Three-bearing, fixed pinion shaft.

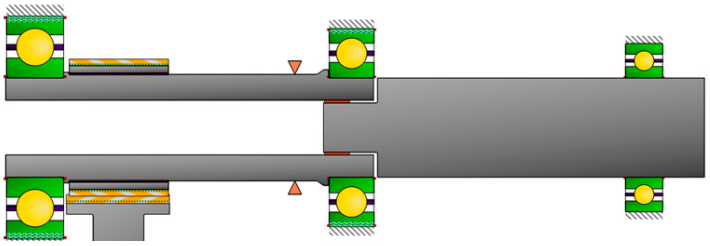

Figure 7—Three-bearing, single shaft.

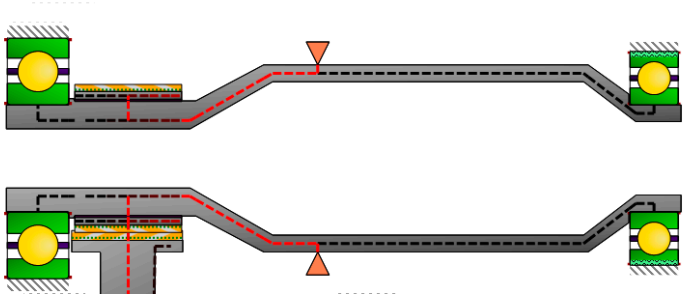

Figure 8—Two-bearing, single shaft.

Arrangements Studied	Gear Alignment	Efficiency	Cost	Other Considerations
1. Four-bearing integrated pin-ion	++	+	//	
2. Four-bearing splined pinion	+	+	//	Potential benefit of reduced scrap input shafts
3. Three-bearing, fixed motor shaft	--	//	+	
4. Three-bearing, fixed input gear	+	//	+	Grounding ring likely needed
5. Three-bearing, single shaft	-	//	+	Three premium bearings can outweigh 4-bearing design
6. Two-bearing, single shaft	+	++	-	Cost of non-uniform shaft

Best ++
Good +
Neutral //
Poor -
Worst --

Table 1—Rotor and input shaft rankings.

References

1. "2025 Will Be the Best Year for New Vehicle Sales since before the Pandemic." Marketplace.org, 2025, *www.marketplace.org/story/2025/12/30/2025-was-a-good-year-for-new-car-sales-in-spite-of-turmoil*. Accessed 6 Jan. 2026.
2. Munro Live on Instagram: "Partial Dissemble of the 2018 Tesla Model 3 Helical Gearbox."" Instagram, Munro & Associates, 2017, *www.instagram.com/p/COiQJ1rniM1/*. Accessed 4 Jan. 2026.