

Two-Speed Ford 9-Inch Third Member

Concept Architecture and Engineering Notes

1. Purpose of This Document

This paper defines a bolt-in two-speed third member for the Ford 9-inch rear axle. It's a proof-of-concept architecture, not a final design, and I'm not claiming it's optimal.

What this device is supposed to do:

1. Provide two discrete final drive ratios at the axle
2. Eliminate the need for multi-speed transmissions in a lot of applications
3. Stay fully mechanical, serviceable, and bench-repairable
4. Use the Ford 9-inch ecosystem as a modular development scaffold

This document intentionally avoids standards language. That's covered in a different paper.

2. Why the Ford 9-Inch Third Member

The Ford 9-inch is selected for development practicality, not because it's absolutely the strongest option out there.

Key reasons:

1. Removable third member makes bench development possible
2. Huge aftermarket supply of gears, bearings, cases, and tooling
3. Known geometry and packaging envelopes
4. Widespread familiarity among builders

Other axle families might ultimately be better hosts for a two-speed system. This is just the starting point.

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3. High-Level Architecture

The two-speed function sits ahead of the differential ring gear, not after it.

What's inside the third member:

1. A conventional differential and ring gear set
2. An inline planetary gear set between the pinion input and the ring gear
3. A mechanical selector that switches between two modes: Direct Drive (High) and Reduction Drive (Low)

There's no neutral position in the third member. If something fails, it defaults to direct mechanical passthrough.

4. Gear Modes and Power Flow

4.1 High Range (Direct Drive)

In high range, the planetary set is mechanically locked into unity. The input shaft is rigidly coupled to the ring gear drive, so power flow mirrors a standard 9-inch third member. You don't pick up any rotating losses beyond bearings.

This is the default and fail-safe condition.

4.2 Low Range (Reduction Drive)

In low range, the planetary carrier drives the ring gear. The ring or sun gear gets mechanically held stationary - final configuration will determine which one.

I'm targeting reduction ratios in the 1.8:1 to 2.5:1 range. This ratio range is intentional. It's large enough to meaningfully change torque and speed behavior, but small enough that you can engage it without shock when speeds are matched.

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5. Planetary Gear Set Rationale

A planetary gear set works here because it provides high torque density, coaxial packaging, symmetrical load distribution, and proven durability in axle and transmission applications.

The plan is to extend the planetary longitudinally to increase tooth engagement length, bearing spacing, and torsional stiffness. Strength comes from geometry and engagement length, not exotic materials.

6. Shift and Actuation Concept

The shift mechanism is fully mechanical, externally actuated, and control-agnostic.

The selector does two things depending on position: it locks the planetary into direct drive, or it locks the appropriate gear element to create reduction.

Engagement happens via dog clutches or splined sleeves. No friction clutches. No synchronizers.

Shifting is intended to happen at zero torque, or with controlled torque matching by the operator or controller upstream.

The shift mechanism is intentionally external and manual so the axle stays control-agnostic. Any future system can actuate it without needing to redesign the internals.

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7. Failure Philosophy

The third member is designed to fail into direct drive. It should avoid neutral or partial engagement states, and it shouldn't rely on pins or pawls as primary torque-bearing elements.

All torque-carrying elements are gears, splines, or bearings. No single shear pin defines system integrity.

8. Serviceability and Rebuild

Design intent:

1. The third member can be removed and rebuilt on a bench
2. No proprietary tools required beyond standard differential service tools
3. Bearings, seals, and fasteners are off-the-shelf where possible
4. The planetary assembly is a subassembly that can be removed independently for inspection or replacement

9. Ratio Selection Philosophy

This is not a multi-speed transmission.

Two ratios are intentional. One optimized for launch, towing, crawling, or acceleration. One optimized for cruise and sustained speed.

When you pair this with high-torque combustion engines, electric motors, or dual-plant architectures, two axle ratios are enough to replace a lot of multi-gear drivetrains.

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10. Intended Pairings

This third member is designed to work downstream of:

1. Forward/Neutral/Reverse modules
2. Torque converters or fluid couplers
3. Dual-input differentials
4. Divorced transfer cases
5. Electric motors or combustion engines

It doesn't assume any specific power plant.

11. What This Is Not

This isn't a transmission, a transfer case, a locking differential, or a complete drivetrain solution.

It's a modular torque multiplier at the axle.

12. Status and Next Steps

This document defines the conceptual layout, power flow, and mechanical intent.

It doesn't define final tooth counts, bearing sizes, housing geometry, or actuator design. Those are expected to emerge through prototype builds and iteration.

13. Closing

If this third member can't be built, tested, and broken by real mechanics, the broader system is irrelevant.

This is the first physical step.

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